THURSDAY, MARCH 7, 1889.

TOLLENS'S "CARBOHYDRATES."

Kurzes Handbuch der Kohlenhydrate. By B. Tollens. (Breslau: Maruschke and Berendt, 1888.)

THIS admirable *précis* of the chemistry of the carbohydrates is a model work of its kind. It is not merely a lucid account of this well-marked group of carbon compounds, but has the rare merit of preserving its facts and conclusions in their original guise—that is, as the offspring of research. Too often, the authors of treatises on experimental science, more especially of the genus text-book, are compelled to present their subject in such a way as to produce the impression that phenomena follow from laws, rather than that laws have followed from the phenomena which they generalize. This is no doubt justifiable, and in the end perhaps not seriously harmful, since the student is soon brought by his laboratory work to an appreciation of the perspective of his science, and to the correction of any superstitions which may have been engendered in his mind as to its origin and up-building. In the book before us, on the other hand, every fact is stamped and recorded as the contribution of a worker. A specialist, such as the author, engaged in active research in the field which he pauses, as it were, to describe, must write from the point of view of the worker; and hence it is that in the 330 short pages into which his account is condensed, we have over 1300 references to original memoirs. The impression produced, moreover, is that he has submitted this huge mass of experimental evidence to a searching examination, of which the matter of the book is the valid survival. It is to be hoped that the author's example will be generally followed. It is becoming less and less possible to keep pace with research in the many special branches into which chemistry is diverging. But if specialists will, as the author has done, unburden themselves to an imaginary interviewer, the task, which is laid upon us all, of keeping up with the progress of discovery and research will be both sweetened and lightened.

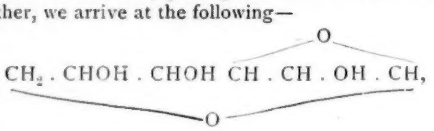
In proceeding to notice more particularly the contents of the work, we are struck, first, with its method of classification. The treatise is divided into two parts, the first dealing with the carbohydrates proper, together with such other comparatively inert compounds, *e.g.* arabinose, as stand in close connection with them; the second is an account of the derivative acids and their lactones ("saccharines").

The first section sets forth the general or typical properties and characteristics of the group, with an account of their origin in the plant, the evidence as to their molecular weight and constitution, their synthetical formation in the laboratory (phenose, acrose), their isolation in the pure state, their optical properties, and the various methods adopted for the determination of specific rotation. Then follows in outline the scheme of classification. The various groups under which the compounds are ranged are: (1) monosaccharides, or glucoses, $C_6H_{10}O_5$ (dextrose, lævulose, &c.); (2) disaccharides, or saccharoses, $C_{12}H_{22}O_{11}$ (cane-sugar, maltose, &c.); (3) polysaccharides—(*a*) crystalline (raffinose, $C_{36}H_{64}O_{32} \cdot 10H_2O$, and lactosin, $C_{36}H_{62}O_{31}$); (*b*) non-crystalline or *saccharocolloids*, &c., $C_6H_{10}O_5 \pm MH_2O$ (starch, inulin, gums, celluloses, pectone substances); (4) the somewhat miscellaneous group of substances which, although lacking some one or more of the group characteristics, are yet closely related to the carbohydrates—(*a*) in which $H : O = 2 : 1$ (arabinose, cerasinose, inosite, formose); (*b*) in which $H : O > 2 : 1$ (quercite, pinite, mannite).

Having thus forecast the order of treatment, the author plunges at once into the work of particular description. Beginning with dextrose, we have at the outset (*a*) a terse but minute account of the laboratory method of isolation from saccharose, also of the method of manufacture from starch; (*b*) certain physical properties of the anhydride and monohydrate, with solubilities and a table of specific gravities of aqueous solutions; (*c*) behaviour towards polarized light,—after a brief discussion of the variations between the numbers of different observers and their cause, we have the author's final selection of the formulæ, (1) for the anhydride $(\alpha)_0 = 52{\cdot}5 + 0{\cdot}018796\,P + 0{\cdot}00051683\,P_2$, and (2) for the monohydrate $(\alpha)_0 = 47{\cdot}73 + 0{\cdot}015534\,P + 0{\cdot}0003883\,P_2$, P being the percentage of substance in solution; (*d*) the results of heating at various temperatures; (*e*) actions of acids; (*f*) actions of alkalies; (*g*) action of nascent hydrogen (conversion into mannite); (*h*) action of the halogens and various forms of oxygen; (*i*) action of oxidizing (metallic) oxides; and (*k*) its several fermentations. Then follows a detailed account of the derivative compounds of dextrose: (A) with bases; (B) with negative radicles; (C) ethereal compounds; (D) hydrazine derivatives; (E) compounds with aromatic amines; (F) with metallic salts; (G) with hydrocyanic acid (conversion into normal heptoic acid). The author then gives a detailed account of analytical methods, *i.e.* (i.) identification by qualitative reaction; (ii.) estimation by polarization of the various oxidation methods (Cu, Hg, and Ag salts), and by fermentation. We have reproduced these heads, under which the chemistry of dextrose is treated, as characteristic of the method of the book. The typical saccharose, cane-sugar, is dealt with in even greater detail, the author giving a complete though brief account of the process of preparation from beet, with illustrated descriptions of the manufacturing plant, as also of the polarization instruments commonly employed for sugar estimation, viz. the Soleil-Ventzke-Scheibler, and that of Schmidt and Häusch.

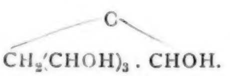
Of the amorphous polysaccharides or saccharocolloids, starch is treated at considerable length. The views of physiologists as to its origin in the plant are briefly discussed. Its resolutions by the various hydrolytic reagents are dealt with in detail, and due prominence is given to the results of the researches of O'Sullivan and of Brown and Heron. Special details are given of the methods of estimation of starch in farinaceous raw materials, with a description of the Lintner-Soxhlet apparatus for carrying out the acid hydrolysis. As the starch group is characterized by resolution into dextrose, so the inulin group, next described, appear to be poly-derivatives of lævulose. A third is composed of substances yielding galactose as a product of resolution (lævulan, galactan, Carragheen mucilage), while a fourth comprises such

gums and mucilages as yield various glucoses, and sometimes also arabinine, as products of hydrolytic resolution (gum-arabic, cerasin, bassorin, "wood gum"). Ascending in the scale of molecular complexity, the celluloses are next described; and lastly, in separate sub-sections, lignin, cork, and pectic derivatives. We have been interested in comparing the author's account of the latter group with those given under "Celluloses" in the new edition of Watts's "Dictionary." There is a close agreement in general method of treatment; and it is satisfactory to find that the problem of the constitution of the celluloses is being worked on such lines as would be laid down from a study of the general view of the carbohydrates which Prof. Tollens has given us. Neither of these acounts of cellulose suggests any probable constitutional formula for the unit group of which the celluloses may be regarded as poly-derivatives; but, putting the views of both authors together, we arrive at the following—

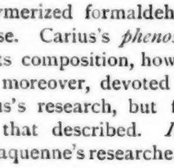


which we think will at least be found of service as a working hypothesis. In the section "Lignin," Prof. Tollens has overlooked some of the researches of recent years, which have, as the result of investigations of its hydrolysis and chlorination, more definitely identified the non-cellulose constituent of lignified tissue with a furfuralic constitution on the one side, and the tendency to an aromatic grouping on the other. In the section "Cork," he has also overlooked some of Fremy's interesting work on the constitution of "cuticular" substances The concluding section of the saccharocolloids comprises the pectic group of plant constituents, which are briefly but fully described.

The fourth section opens with an account of *arabinose*, which the author represents by the constitutional formula—



Formose, or polymerized formaldehyde, is not regarded as a true glucose. Carius's *phenose* is described; the evidence as to its composition, however, is very slender. The writer has, moreover, devoted some time to a repetition of Carius's research, but failed to obtain any product such as that described. *Inosite* is represented on the basis of Maquenne's researches, by the symmetrical formula—



Dambonite and *bornesite*, which are found in caoutchouc-yielding juices, are described as the mono- and di-methyl ethers of inosite, respectively.

The fifth section comprises the hexahydric alcohol mannite and its isomerides, dulcite, sorbite, and perseite, of which the typical mannite is fully described.

The second part of the work gives a detailed account of "substances closely related to the carbohydrates, and obtained for the most part from them, which are either acids or acid-anhydrides (lactones), and the molecule of which contains 6 C-atoms": (*a*) saccharinic acid, $C_6H_{12}O_6$, and its isomerides, iso- and *meta*-saccharinic acids, their lactone-anhydrides, $C_6H_{10}O_5$, "*saccharines*," and their oxy-derivatives, *saccharones*, $C_6H_8O_6$; (*b*) gluconic acid, $C_6H_{12}O_7$, and its isomerides, galactonic and arabinose carbonic and mannitic acids; saccharic acid, $C_6H_{10}O_8$, and its isomerides, mucic, iso-, meta-, and para-saccharic acids, with their lactonic and other derivatives.

Such is a brief account of the contents of the book before us. The main purpose is necessarily the theoretical treatment of the subject—from the point of view, that is, of pure chemistry; at the same time due prominence is given to technical considerations, and the physiological aspects of the subject are by no means excluded.

We do not believe that we are yet within measurable distance of a knowledge of the actual molecular constitution of the carbohydrates. We do not even think that the evidence for the C_6 formulæ of the simplest members is at all conclusive. One of the assumed criteria of this point—the calculation of molecular weight from the lowering of the freezing-point of solvents by the presence of compounds in solution, as proposed by Raoult—is not mentioned by Prof. Tollens. At a recent meeting of the Chemical Society, Messrs. Brown and Morris communicated the results of an investigation of the freezing-point of solutions of the simpler carbohydrates, which appear to confirm the generally accepted views. Nevertheless, it would be premature to pronounce at all positively, either as to this particular criterion, or as to the evidence generally on these points.

The chemistry of the carbohydrates brings us into contact with the syntheses and transformations of the organic world. The plant is, and will remain through all time, the chemist's ideal. Every contribution to the chemistry of the carbohydrates is a step towards a comprehension of the chemistry of elaboration. The number of workers in the field is relatively small, but will increase as the methods of investigation are rendered more precise. It is from this point of view that we commend this little work to the notice of all who have either a special or general interest in plant-chemistry.

BRITISH MOSSES.

British Mosses. By F. E. Tripp. 2 Vols. New Edition. (London: George Bell and Sons, 1888.)

THE fact that a new edition of this work has been called for shows that these elegant plants have a wide-spread circle of admirers, and that there are many seekers after a knowledge of their structure.

The introduction occupies thirty-eight pages. In Sect. 1, on the homes of mosses, we have a highly poetical description of the third day of Creation, and production of vegetation according to Genesis. This is followed by the natural distribution and habits of the mosses; and by charming word-pictures of woods and moorlands the authoress compels her readers to accompany her and see for themselves the beauties that await observation on every side and at every season.

Sect. 2, the characteristics of mosses, is written in

somewhat the same poetic strain, and glances at the leading aspects of mosses in natural scenery. Sect. 3, structure of mosses, gives a clear and succinct outline of the various organs of these plants, and their functions. Sects. 4 and 5, collecting and examining mosses, and uses of mosses, are the best in the book, and show the devotion of the writer to the study of this branch of botany. Then follows a synopsis of genera after Schimper's "Syn. Musc. Eur.," and at p. 45 we arrive at the description of species and plates, to which the remainder of the work is devoted.

The descriptions are all on one uniform plan, very short and under five heads—colour, stems, leaves, capsule, locality. The text is therefore somewhat monotonous and dry, while the essential points characteristic of the species are not always brought out; *e.g.* the Bryinæ are "Plants cellular, germinating from spores, with stems and leaves; fruit a capsule," which applies equally well to the Hepaticæ. With species this want of definiteness in description is apt to lead altogether astray. In other instances an erroneous term is introduced; thus *Trichostomum nitidum* is stated to have leaves "hairy at apex," *T. litorale* leaves "with short hair-points," whereas both have solid conical points, formed by the nerve.

The cell-structure of the leaves is a most important character, and is requisite both in descriptions and illustrations, but is not treated sufficiently in either. The 37 plates represent the plants of the natural size, and are very well coloured, so that the larger species may be readily recognized; but the leaves are not sufficiently magnified nor their structure sufficiently defined to render them sure guides, for the smaller species are too much alike, and the smallest of all, represented on Plate 5, it would puzzle any bryologist to discriminate.

Although for these reasons the work is not so helpful to the student as it might be, it forms an elegant table book. The paper is excellent, and the clear symmetric printing could hardly be surpassed.

OUR BOOK SHELF.

Catalogue of the Marsupialia and Monotremata in the Collection of the British Museum (Natural History). By Oldfield Thomas. (London: Printed by order of the Trustees, 1888.)

THIS is one of the new series of Zoological Catalogues of the British Museum, which, from their containing descriptions of all the known species of the group catalogued, form handy and excellent hand-books for the student, and serve for much more than records of the treasures of our British Museum.

This volume contains the descriptions of 151 species of Marsupials and 3 of Monotremes, in addition to descriptions of 12 well-marked varieties of the former and 2 of the latter order. Of this large total of 168, only 20 are not represented in the British Museum collection. The specimens amount to 1304 in all, of which 173 are preserved in spirits.

This is a very marked increase above the number in the list published in 1843, in which but 94 species were enumerated. Apart from the number of species represented in the collection, the value of these is greatly increased when they are "type" forms. In such forms, the British Museum is extremely rich, possessing 74, followed by the Paris Museum with 21, and then, at a long distance, by the Museums of Sydney and Leyden, with 8 each. In this Catalogue, probably for the first time, a double synopsis of each genus and species is given, in order to enable the student to identify a specimen either from its external characters, or from its skull alone. In order to make these latter synopses useful, explanations of the nomenclature and of the measurements are given.

The synonymy of the genera and species is worked out in very great detail, and in the case of the Monotremes we have in addition references to the literature bearing on the anatomy, embryology, &c., of the forms belonging to the order.

Although most of the species of Marsupials have been named within the last hundred years, and the greater number of them have names of quite recent date, yet the hasty descriptions of some authors have added much to the list of synonyms. In addition to the ordinary synonymy, Mr. Thomas has in most instances given references to the more important papers on the anatomy of the forms. These references make this Catalogue useful to the comparative anatomist as well as to the zoologist. To make such a list perfect would require much space, but, so far as we can judge, all the more important papers have been referred to; under *Phascolarctus cinereus*, we would add one on its anatomy by Prof. Macalister, in the *Ann. and Mag. Nat. Hist.*, 1872, vol. x., and one on the occurrence of a premaxilla-frontal suture in the skull, by Prof. Mackintosh (Proc. Roy. Irish Acad., n. s., vol. iii.).

We hope the day is not far distant when all the mammals in the British Museum collection will be catalogued in an equally accurate and effective manner.

Report of the Proceedings of the United States Expedition to Lady Franklin Bay, Grinnell Land. By Adolphus W. Greely. Vol. I. (Washington: Government Printing Office, 1888.)

EVERYONE knows, at least in its main outlines, the story of the Polar Expedition commanded by Lieut. Greely. Three years ago (NATURE, vol. xxxiii. p. 481) we reviewed the work in which he presented an interesting popular account of his experiences. The present volume contains the official Report, dated Washington, June 30, 1885, which Lieut. Greely addressed to the Chief Signal Officer of the United States army; and a singularly fascinating Report it is—all the more fascinating as no attempt is made to set forth the facts in a lively or picturesque style. The writer is so completely occupied with the events he records that he seems to have neither time nor inclination for any thought about the manner in which they should be presented. As appendices to the Report an immense number of documents relating to the Expedition are printed; and many of these are of considerable value, not only supporting the statements of the Report, but adding details which give freshness to the central narrative. The volume is enriched by an abundant supply of excellent full-page illustrations, illustrations grouped in plates, illustrations in the text, and maps and charts.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Origin of Coral Islands.

MR. MURRAY'S concise explanation of the formation of coral reefs and islands presents advantages in more than one respect. It demands no *a priori* assumptions, but begins and ends with that which can be observed, while Darwin's theory requires the preliminary concession of subsidence, which never has been and never

perhaps can be observed. It must appear ungracious to question a theory that accords so completely with the natural history of coral islands, but even this theory requires a geological concession, and that is stability. Coral islands, it may be supposed, after all only differ from other oceanic islands in being crusted over with coral, so that we cannot see their original state, and the question is whether we can grant such long periods of stability to them, from our experience of other oceanic islands, which are free from coral and can therefore be observed. Nearly all oceanic islands are volcanic, and it is probable that their elevation coincides more or less with the period of volcanic activity somewhere along their line. It is obvious that coral islands are not formed during this phase, because no theory would then hold good; the peaks would grow through and carry up the coral, which might leave only such small traces of its existence as we find in a single spot in Madeira. It would not be unreasonable to suppose that if the expansive and elevating force were withdrawn the peaks would slowly subside, and that if there are some lines of elevation, there must be others of subsidence, unless the earth is as a whole growing in bulk. Darwin claims the existence of areas of subsidence, and that these are eminently favourable to coral growth, and it is quite apparent that if the Island of Madeira were to sink, as it has undoubtedly risen, its last appearance in a coral sea would be as an atoll. We shall never see the interior structure of a stationary or subsiding coral island, and can only look for a re-elevated example with a crust that has been protected from solution whilst dead and submerged, and yet not sufficiently so to mask the core.

In submitting geological considerations I am not questioning any of Mr. Murray's observations, which are in every way admirable, though it does appear to me doubtful whether atolls could increase outwards in deep water on their own talus, in face of the dissolution of dead coral that is claimed to take place in the interior of the lagoons, and yet more so in deeper water.

J. STARKIE GARDNER.

The Sun's Corona, 1889.

A GENERAL statement of the successes of the Western Eclipse Expeditions on January 1 has already appeared in NATURE. More photographs of the corona were taken than ever before—many of them indifferent and worthless, but an unusually large number of great excellence. The best that I have so far seen were taken with 5-inch telescopes, by Mr. W. H. Pickering at Willow, and by Captain R. S. Floyd at Lakeport, both in California. The latter's lens was newly made by Clark, on the Stokes-Pickering plan, convertible from optical to photographic use by reversing the crown lens.

Until the photographs can be well collated, there is little use in presenting them; and the difficulties arising in this work are by no means easy to meet.

With the drawings, however, the case is different. These were made in great abundance, and I have received sufficient responses to my printed instructions to afford very satisfactory conclusions as to the appearance of the corona. The state of the sky was practically everywhere favourable throughout California, Nevada, Idaho, Wyoming, Montana, Dakota, and Manitoba.

The instructions for sketching the corona were printed in three sections: (1) drawings of the corona as a whole; (2) drawings with small telescopes of the filaments about the solar poles; (3) sketches of the outlying streamers along the ecliptic. These latter were made with the assistance of an occulting disk, set up at such distance from the eye of the observer that it would subtend an angle of 65′. It was supposed that disks of this size, being much larger than those used on any previous occasion, would hide very nearly all the inner corona, and leave the eye free to follow the faint outer filaments to their farthest limit. The magnitude and brilliancy of the inner corona, however, were such as to convince me that the disks might better have been one-fourth larger.

From the best of all the drawings now available, of the three classes, Mrs. Todd has prepared the accompanying sketch of the corona. This was done without knowledge of the details shown on any of the photographs, and it may be taken as an index of the sort of results which may be derived from the co-operative plan of figuring the optical corona. It is also instructive in studying the differences between the optical and the photographic corona.

DAVID P. TODD.

Amherst College Observatory, February 22.

[No sketch was received with this letter.—ED.]

The Meteoric Theory of Nebulæ, &c.

THERE would appear to be a difficulty in the theory of the meteoric constitution of nebulæ,[1] &c., which, as far as I am aware, has not been mentioned.

It is, namely, the fact that some gas—probably part of it permanent—exists in the nebula along with the moving masses in translatory motion. Making allowance for the relatively small effect of gravity on the gas, due to the diffuse distribution of the matter, and consequently having regard to the probable tenuity of the gas; it has nevertheless, I find, been estimated by Joule ("Scientific Papers," vol. i. p. 539) that meteors are first observed at a height of 116 miles in the earth's atmosphere. He estimates that 0·0003 of a grain of air is contained in a column of air one mile long, and one square foot in cross section at that height. This, I find by calculation, amounts to 1/1000 millionth of an atmosphere in round numbers as to density.

So that if in some nebulæ the gas had something like this small density, the bodies, or masses moving in translatory motion according to the kinetic theory, would (if their velocity were at all comparable to that of those colliding in the earth's atmosphere) behave as meteors, or inflame; and so apparently be rapidly converted into gas. Even if they did not inflame; no doubt the heat consequent on friction would be considerable. It might be suggested, perhaps, that the mass of these bodies in some nebulæ may be so great that they do not lose their translatory motion rapidly, even if they leave a luminous track. In any case it is evident that this stage of evolution is not a lasting one, and, to my mind, it seems that it is less permanent than is perhaps generally supposed.

I find that Mr. G. H. Darwin, in his paper in the Philosophical Transactions, 1889, above alluded to, suggests the hypothesis that the "metallic rain" generated by the condensation of the incandescent vapour of iron could "fuse with old meteorites whose surfaces are molten." It seems to me that the rate of translatory motion, calculated by him at $5\frac{1}{2}$ kilometres per second, is scarcely allowed for here. How, it may be asked, could such "metallic rain" fuse on bodies colliding against it at this velocity? Some are moving at a less velocity, no doubt; but some are moving at a greater.

The temperature equivalent to this value for translatory motion ($5\frac{1}{2}$ kilometres per second) is, I find, 36,000° C. (about); *i.e.* this would be the temperature if the translatory motion alone were entirely converted into heat. Clausius has calculated, I believe, that in a gas the ratio of the whole energy (which includes translational and vibrational energy of molecules) is to the vibrational energy alone as the specific heat at constant pressure is to that at constant volume.[2] If this be the case, a very large proportion of the translatory motion is resolved into internal motion—that motion which emits the waves of heat analyzed in the gas. Must not the same be true of meteoric masses: or is not the principle (ratio) independent of the *scale*, or number of molecules clustered about a centre, and moving as one lump in the motion of translation? In some complex gases, at least fifty to sixty molecules may be clustered about a centre to form a lump. Then if more (as in a meteorite) are so clustered, it appears that the same must hold true, as regards subdivision of the energy between translatory motion and vibratory motion (heat). If so, by the great temperature equivalent of the translatory motion (viz. 36,000° C. above estimated), the meteorite would rapidly be dissociated into separate molecules by the subdivision of the energy according to the above principle—just as the more firmly united constituents of the lumps (*i.e.* compound molecules) of gases would be dissociated, even if moving at but a fraction of the above translatory velocity.

Is it supposed perhaps that the length of path between encounters (giving time to cool?) in meteorites constituting nebulæ, prevents this? This point is not apparently gone into in Mr. Darwin's paper. But if the meteoric mass has time (nearly) to cool down, or lose, by radiation into stellar space, the heat generated at each successive collision, then it would seem that the translatory motion would be somewhat rapidly lost by con-

[1] I allude specially to Mr. G. H. Darwin's paper, "On the Mechanical Constitution of a Swarm of Meteorites," of which an abstract appeared in NATURE of November 22 and 29, 1888 (pp. 81 and 105). The paper is contained in full in the Philosophical Transactions, vol. clxxx., 1889.

[2] It may be curious to observe that, if a meteoric swarm whose mass equalled that of the sun, were contained within an impenetrable envelope, whose radius equalled the radius of Uranus's orbit (nearly), the mean density of the meteoric swarm would be one five-millionth of an atmosphere only; which represents a fair "vacuum" of a Sprengel pump. This degree of distribution of matter may be represented by a centimetre cube of iron placed at the corner of a cube 139 metres in the side.

version into heat (wasted in space); and this, again, is an indication of the relatively small permanence in such a system, before pointed out as a probable fact. If there is not much free gas in a nebula, the heat radiated by the meteoric masses into space will be great, because unobstructed by the gas. If, on the other hand, there is much free gas in the nebula, it will fritter the translatory motion down by friction into heat. A translatory motion whose temperature equivalent (36,000° C.) is from ten to twenty times more than sufficient to volatilize the moving masses, if utilized, could scarcely exist for a lengthened epoch, or this would seem to be an unnatural state of things.

If the meteoric masses had a mean length of path at all comparable in relative scale to that of a gas at normal density; such as, for instance, if the mean path were (merely for illustration) 1000 times the diameter of the meteorite; then it is evident that the whole system—by a translatory motion of $5\frac{1}{3}$ kilometres per second—would be resolved into gas in a few minutes or even seconds of time. The question then becomes, as it seems, How far does lengthening the mean path diminish the tendency to resolution into vapour by allowing time to cool between the encounters? or some mechanical relations might possibly be demonstrated here from elements[1] or physical data determinable apparently. S. TOLVER PRESTON.

Paris, February.

Upper Wind Currents over the North Atlantic Doldrums.

THE following observations were taken on board the steamship *Araucania* on her voyage from Liverpool to Valparaiso in December last:—

From the Cape Verde Islands down to 9° N. lat. the surface wind was steadily north-east, but the low clouds came as persistently from south-east, and the middle or high layers from south-west.

About 5° N. the wind worked gradually through east to south-east, and we experienced no calm doldrum, nor even a belt of variable winds. From here to the equator the surface wind remained south-east, while the low clouds came from between south and south-east, but the middle and high layers still passed from south-west.

From the line till about 10° S., while the surface wind continued to blow from south-east, the high cirrus moved from the north-west.

The circulation of the atmosphere, indicated by these observations, is very different from that described by myself in your columns on two former occasions. On one, while traversing the same track as now, only in the month of July 1885; and on another while going from Cape Verde to Cape Town in December of the same year, I found the highest current over the doldrums coming from the east. Now there was no doldrum at all, and though there were 200 miles of latitude between the place where the last south-west highest current and the first north-west highest current were observed, it seems somewhat improbable that there was a narrow belt of high-level east winds between these two currents from some point of west.

It may be noted that cirrus came from the south-west for about 300 miles of southing over the south-east trade, and that a low current from south-east blew over both trades from 6° S. to 13° N. RALPH ABERCROMBY.

Straits of Magellan, January 15.

The Giant Earthworm of Gippsland.

IN the last issue of NATURE (p. 394) I observe in an article upon *Megascolides australis* that a supposition is expressed that very large earthworms will be found to occur in South America as well as in other continents. It may be of a little interest to mention that I found near the town of Manaos, in Amazonia, in the year 1874, an earthworm that measured 30 inches in length by $\frac{3}{4}$ inch in greatest breadth. When found, in the early morning, it was quite fresh, though newly dead, being somewhat crushed near one end, probably by some passer-by in the darkness. Unfortunately the worm spoiled in the rum in which I attempted to preserve it. JAMES W. H. TRAIL.

University of Aberdeen, February 27.

Weight and Mass.

PROF. GREENHILL seems to have overlooked the fact that my letter in NATURE of February 7 (p. 342) related entirely to procedure in teaching. I merely stated that as the result of experience I have found it absolutely necessary to use terms strictly in the senses assigned to them by definition, and not to use the same term in two senses. I find that it conduces to clearness and accuracy to use the word "pound," for example, only in the sense of a certain quantity of matter, and to use the phrase "weight of a pound" when speaking of the force of gravity on that quantity of matter.

With the ordinary expressions used by engineers when addressing engineers or other persons who, presumably, are able to distinguish between the different senses in which the same term or phrase is used, I have no quarrel whatever, and must decline Prof. Greenhill's invitation to express an opinion as to the accuracy of the phrases which he quotes from NATURE.

University College, Bangor, February 25. A. GRAY.

The Formation of Ice.

IN connection with the discussion on the formation of ice in crystals, it might be worth while to record that on December 6, 1861, in a slight frost, I saw some in the process of formation in a trough of water. There were three thin pieces of ice in it, two irregular, but the third a beautiful star, 4 or 5 inches in diameter, having six feather-like rays which were branched twice or thrice, in all cases at an angle of 60°. Also, two days before, when the water in the trough was frozen over, I observed in it six-rayed stars several inches in diameter very slightly raised above the rest of the surface. T. W. BACKHOUSE.

Sunderland, March 2.

ROTIFERA AND THEIR DISTRIBUTION.[1]

IT is no longer possible, I think, for your President to give, as the substance of his address, a summary of the most important improvements of the microscope, and of the most remarkable results of microscopical research, which have been recorded in the preceding twelve months.

All this is now so fully and so admirably done in your own journal, by your energetic Secretary and his able colleagues, that your Presidents will most probably, in future years, have to follow the excellent precedent set by Dr. Dallinger, and choose for the subject of their address some topic directly springing from their own special studies. For, on an occasion like this, each President would wish to give the Society the best he can, and it is clear that this best must be sought for among matters of which he has a special knowledge.

Unfortunately, an accident, which befell me early last year, not only robbed me of the pleasure of being present at several of your monthly meetings, but also produced consequences that compelled me to put my microscope aside; and, as I had not long before finished my share of the "Rotifera," I feared at first that I had lost the power of pursuing any new investigations, just at the very time when I had published the results of all my old ones.

There is, however, still a portion of my subject with which I am familiar, and which, I believe, has not as yet been touched upon by anyone; and I venture to

[1] It is said that "The total energy of agitation in an isothermal adiabatic sphere is half the potential energy lost in the concentration from a condition of infinite dispersion" (NATURE, Nov. 29, 1888, p. 107). This is apparently the analogue of the ratio of Clausius, somewhat differently expressed, viz. the ratio between the two parts of the energy, translational and vibrational (internal motion), applicable to a rigid body, and calculated at $\frac{1}{2}$ *a priori* by Maxwell. I would venture one remark here. It appears evident that if the mean thermal equivalent of *half* the potential energy lost were all accumulated in the meteorites, they would be volatilized. If, on the other hand, part of this thermal equivalent were dissipated in space by radiation, the meteorites could not possess their natural equivalent of thermal energy due to the translatory motion, and consequently it would seem that in the continued effort towards the equalization of these two forms of energy (translatory and thermal), the translatory motion would with tolerable rapidity degrade down to a value which could no longer support the weight of the superincumbent material. This would be another argument for the small degree of permanence of such a system.

[1] Address delivered at the Annual Meeting of the Royal Microscopical Society, by Dr. C. T. Hudson, President, on February 13, 1889.

hope that I may make it interesting to you. It relates to what may be called the foreign Rotifera; that is to say, to those Rotifera which have not as yet been found in our islands. One would naturally like to know what proportion these foreign species bear to the British; whether there are any families or genera entirely absent from the British fauna; whether there appears to be any law of distribution among the Rotifera; and how far it is possible to account for the existence of the same species in places which are thousands of miles apart. But many of the numerous memoirs, from which information on these points is to be derived, are only to be found, scattered widely, in various European periodicals; and so are difficult to be procured; while, of those that have been published separately, the best are rare.

Under these circumstances I thought it not improbable, that the members of our Society might be glad to know, that the task of studying and condensing these memoirs had been, in the main, accomplished; and that I am able now to present them with some of the results.

In the first place, I made a list of all the known species, and marked against each the various localities in which it has been found. It was curious to see, as the table grew, how certain well-known Rotifera were picked out by their rapidly advancing scores, till at last about fifty typical Rotifera were separated from the rest; while, of these, a smaller group enjoyed the further distinction of having a very wide range, not only in latitude and longitude, but also in altitude.

The same table showed at a glance that Great Britain decidedly outstripped all other countries in the number of its recorded species, having quite two-thirds of the whole. Nor was this all, for the Rotifera seemed, like trade, to follow the flag, and to haunt the British colonies just as if they were British ships.

The reason, for this curious pre-eminence of British Rotifera, is clearly seen when we notice how those species are distributed, which have as yet been found in one country only. There are about 240 such species, and of these no fewer than 173 (that is to say, more than two-thirds) are peculiar to Great Britain. It is, of course, obvious that this apparent selection of Great Britain as the fatherland of the Rotifera is simply due to the greater energy, industry, and skill with which the search for new species has been pursued in this country. It is, however, very remarkable that the naturalists of Great Britain should, in late years, have added to the Rotiferous fauna two and a half times as many species as the naturalists of all other countries put together have done; and this highly honourable result is mainly due to members of your own Society, and especially to my deeply-lamented colleague and dear friend, the late Mr. Philip Henry Gosse, F.R.S.

After I had seen how greatly the value of the recorded distribution of the Rotifera was affected by what I may term the "personal equation," I at first feared that I should obtain little else from my tables than a well-merited tribute to the energy of British naturalists. Further inspection, however, showed other points that are well worth your notice.

In the first place, my lists showed that Germany, Switzerland, and Hungary come next in order to Great Britain, in the total number of species that each records; and I have only to mention the names of Ehrenberg, Leydig, Cohn, Grenacher, Zacharias, Eckstein, Plate, Imhof, Perty, Bartsch, Vejdovsky, Zelinka, not to say many others, to make it obvious that the result is due, not to the real distribution of the species in these countries, but to the comparative skill and industry of their naturalists.

Next, my table shows clearly that in all cases a considerable number, and in some the great majority, of the above-named fifty typical Rotifera, range throughout Britain, France, North and South Germany, Denmark, Switzerland, Hungary, and Russia; so that we may reasonably conclude that a considerable proportion of the 450 known species would probably be found in almost any part of Europe, if they were diligently searched for. Here, for instance, is a list of thirty well-known Rotifera, all of different genera, and all recorded in at least five of the above eight European countries:—

Floscularia ornata	Diglena catellina
Stephanoceros Eichornii	Mastigocerca carinata
Melicerta ringens	Rattulus lunaris
Limnias ceratophylli	Dinocharis pocillum
Lacinularia socialis	Scaridium longicaudum
Philodina roseola	Salpina mucronata
Rotifer vulgaris	Euchlanis dilatata
Actinurus neptunius	Cathypna luna
Asplanchna helvetica	Monostyla cornuta
Triarthra mystacina	Colurus uncinatus
Hydatina senta	Metopidia lepadella
Notommata aurita	Pterodina patina
Proales decipiens	Brachionus urceolaris
Furcularia forficula	Anuræa aculeata
Eosphora aurita	Notholca striata.

Besides, many of the Rotifera are very tolerant of climate, and appear to be able to live anywhere that they can get food. For instance, *Rotifer vulgaris* is to be found all over Europe, and at all heights; thriving under moss, near the top of the Sidelhorn, and on the Tibia, at an altitude of 9000 feet above the sea. It has been met with also in Nubia, on the slopes of the Altai Mountains in Siberia, in Ceylon at the top of Adam's Peak, in Jamaica, and in the Pampas of La Plata. *Brachionus pala* has nearly as great a range; for it has been found in many parts of Europe, in Egypt, at the Cape of Good Hope, in Siberia, Ceylon, Jamaica, and New Zealand. Besides these, *Diglena catellina*, *Hydatina senta*, *Actinurus neptunius*, and a few others, have all been met with in different quarters of the globe. But the distribution of the Rotifera presents us with other facts quite as curious as these. For not only are European species to be found ranging over Asia and Africa, but America, and even Australia and New Zealand, in spite of their ocean belts, possess the same familiar creatures; and, moreover, seem to have hardly any peculiar to themselves. Here, for example, is a list of Rotifera that have been found in Sydney by Mr. Whitelegge, and in Queensland by Mr. Gunson Thorpe:—

Floscularia ornata	Conochilus volvox
,, campanulata	,, bullata (*n. sp.*), *T.*
,, cornuta	Asplanchna Brightwellii
,, Millsii	,, ebbesbornii
,, coronetta (*var.*), *W.*	Cephalosiphon limnias
Melicerta ringens	Actinurus neptunius
,, conifera	Rattulus tigris
Œcistes crystallinus	Notommata centrura
,, janus	Euchlanis triquetra
Limnias ceratophylli	Dinocharis pocillum
,, annulatus	,, triremis (*n. sp.*), *W.*
,, cornuella	Brachionus militaris
Lacinularia socialis	Anuræa cochlearis
,, pedunculata (*n. sp.*), *W.*	Pedalion mirum.

Mr. Thorpe has also found what seems to be a swimming Floscule, with a forked foot and a dorsal eye; as well as a new *Noteus* or *Brachionus*, with a strangely unsymmetrical lorica, bearing ten spines in front, and three behind. Who would ever have imagined that, in a sea-girt continent, at the opposite side of the globe—in a land whose fauna and flora are so strange as those of Australia—we should find that twenty-four out of thirty recorded species were British; and that, of the remaining six, one (*Floscularia Millsii*) had a habitat in the United States?

The United States, too, Jamaica, and Ceylon all reproduce the same phenomenon, though on a reduced scale; so that the question at once arises, How could these

minute creatures, who are inhabitants of lakes, ponds, ditches, and sea-shore pools, contrive to spread themselves so widely over the earth? Take, for instance, the case of *Asplanchna ebbesbornii*, which till quite lately had but one known habitat, viz. a small duck-pond in a vicarage garden in Wiltshire. The very same animal has been found by Mr. Whitelegge in the botanical gardens at Sydney, New South Wales. No doubt, in time, it will be found elsewhere also; but how, or when, did it pass from the one spot to the other?

Again, there is the strange Floscule, *F. Millsii*, a Rotiferon apparently linking together the genera *Floscularia* and *Stephanoceros*, and which has been found almost simultaneously by Mr. Whitelegge at Sydney, and Dr. Kellicott at Ontario. The possibility of its journeying between two such points seems quite as hopeless as that of *Ashplanchna ebbesbornii's* passing from New South Wales to Wiltshire.

And such cases are numerous. How did *Hydatina senta* and *Brachionus pala* get to New Zealand? or *Notops brachionus* and *Rotifer vulgaris* to the top of Adam's Peak, and the Pampas of La Plata? Again, there is *Pedalion mirum*: since I first found it, in a pond at the top of Nightingale Valley, at Clifton, it has been met with in four or five other places in England, including a warm water-lily tank at Eaton Hall; but, till quite lately, in no other country. Now I have just received a letter from Mr. Gunson Thorpe, telling me that he has found it swarming in a pool on a rocky headland in Queensland.

You have, no doubt, long ere this anticipated the solution of the puzzle, and see clearly enough that living creatures, to whom a yard of sea-water is as impassable a barrier as a thousand miles of ocean, could only have reached or left Australia, New Zealand, Jamaica, Ceylon, &c., in the egg; not the soft, delicately shelled, and quickly hatching summer egg, but the ephippial egg, which is protected by a much harder and thicker covering, which is constructed so as to bear without injury a long absence from the water, and which hatches, so far as is known, some months after it has been laid.

But this explanation still requires to be explained. The case of the free-swimming Rotifera is simple enough. They are most of them to be found, at some time or another, in small shallow pools, and their eggs either fall to the bottom of the water, or are attached to the small confervoid growth on the stones in it. Such pools frequently dry up, leaving the ephippial eggs to wait for the rainy warm weather of next year. Then comes boisterous weather, and the dusty surface of the exposed bottom of the pool is swept by a wind, which raises the dust high into the air, ephippial eggs and all. For these latter are minute things; few exceeding one three-hundredth of an inch in length, and many even half that size. Once raised in the air, I see no reason why they should not be driven by aërial currents, unharmed, half round the globe, falling occasionally in places where water, temperature, and food are alike suitable.

The dust of the eruption at Krakatão, which gave us such wonderful sunsets and green moons in 1883, travelled from the Sunda Isles to England in three months; and so the ephippial eggs of *Asplanchna ebbesbornii*, and other Rotifera, may have traversed the distance from England to Australia, and yet have been capable of hatching at the end of the journey.

It may perhaps seem a fanciful notion to account for the stocking of the ponds at Sydney by eggs carried thousands of miles in the air, but several well-known facts warrant the hypothesis. The tops of our houses, the heights of the Alps, the slopes of the Siberian mountain ranges, are haunts of the Philodines, which, being an exceptionally hardy race, have accommodated themselves to living in damp mosses at the edge of a glacier, or in a gutter which now holds a mere handful of stagnant water, now is a racing current, and now a dusty leaden basin, glowing under a blazing sun. No doubt eggs of all sorts of species fall on the same spots, but only to perish under trials that none but a Philodine could survive.

How various are the species whose eggs are thus wafted up by the air has been well shown by Mr. J. E. Lord, who has given a list of no fewer than forty-five species (contained in twenty-nine genera) that he found, in the course of twelve months, in the same garden pond. It was, however, admirably situated for catching whatever there was to be caught, for it lay in a flat plot of ground, where there was an entire absence of trees and shade, so that its surface was fully exposed to every wind that blew.

The eggs, of course, must often fall on unsuitable places, and be carried past suitable ones, and this accounts for the capricious appearances of Rotifera in some well-watched ponds, and for the frequent disappointments of the naturalists who visit it. To this aërial carriage of the eggs is also due the otherwise perplexing fact that, when any rare Rotiferon is found in one spot, it is frequently found at the same time in closely neighbouring ponds and ditches, even in such an unlikely hole as the print of a cow's foot filled with rain, but not at all in more promising places at some distance off.

Admitting, then, this fitful shower of eggs as proven, we at once see another way in which they may readily travel to distant lands. For it is quite possible that now and then they may fall on the cargo of an outgoing ship. Here they might lie safely in cracks and creases till, the journey being over, the knocking apart of packing-cases and the shaking of wrappers would set them afloat again, to drop down, it may be, into the Botanical Gardens of Sydney, the shore-pools of Ceylon, or the ponds of Jamaica. In fact, these Rotifera would have really done what I have already pointed out that they seemed to do—they would have followed the flag.

The eggs of the tube-makers, however, and of such Rotifera as live only in the clear waters of lakes and deep ponds, present a greater difficulty, for their eggs either lie within their tubes, or are attached to growing weeds, or fall down to a bottom which lies covered all the year round with several feet of water. The wind and sun here cannot be the only means of dispersion. Aquatic birds, and dogs, are probably assisting agents. The birds, as they swim among the water-plants, must frequently set free the eggs from the tubes of the Rhizota, as well as those which adhere to Confervæ, Potomagetons, and water-lilies, and so get them attached to their feathers. Then away they fly, carrying the eggs to some far distant lake, or shaking them off into the air with the flapping of their wings.

In confirmation of this idea, I may mention that the well-known naturalist, Mr. John Hood, of Dundee, who has added so many remarkable species of Rhizota to our Rotiferous fauna, informs me that the Scotch lakes most prolific in new and rare species are those which are visited annually by wild fowl from the North. Prof. Leidy also informs me that his collector, Mr. Seal, noticed sand-pipers haunting the duck-pond where he found an *Asplanchna* very similar to *ebbesbornii*, and that he thought that "these birds were especially instrumental in distributing the lower forms of aquatic life." I may also add that on one occasion I found in a temporary rain puddle, barely a yard across, a living ciliated ovum of *Plumatella repens*. Of course the puddle itself contained no adult forms, and the ovum must have been brought by some bird the distance of at least half a mile. The twin polypes were already partially developed inside the ovum, and it is curious that so delicate a thing should have borne this transport safely.

Dogs probably play a humbler part in the dispersion of the Rotifera; but they cannot help taking some part in it, by intercepting, as they swim, eggs that are slowly sinking

to the bottom, or by brushing off, on to their coats, eggs which have been already caught by the weeds; for the ephippial eggs are frequently armed with hooks or spines, which make them adhere easily to a pond-weed or to a hairy coat, and yet would not prevent a dog's vigorous shake, after his bath, from sending them flying into the air, or on to the dust, where sun and wind would do the rest.

Perhaps one of the most curious illustrations of this aërial conveyance of Rotiferous eggs is the account of *Callidina symbiotica*, which we owe to Dr. Carl Zelinka. It was in the depth of last winter that I read his interesting memoir, concerning a new *Callidina* that he had discovered inhabiting the little green cups on the under surfaces of the leaves of a scale-moss (*Frulliana dilatata*). As I knew that this plant grew on the elms of our Clifton promenade, I started off at once, on the rather forlorn hope of finding some living specimens of the new Rotiferon. When I arrived at the promenade I passed patch after patch of the scale-moss, hoping in vain to find something more promising than the withered liver-coloured stuff which alone was to be seen on the tree-trunks. At last I gave up further search, and pulling off a scrap of what looked like old ragged carpet, I carried it home. There I put a bit of it into a watch-glass, covered it with water, and gently teased it out with needles, till I found an under frond that had some pretension to being green. This I transferred to a glass cell, and placed it under the microscope with the cups turned towards me; and it was with no little pleasure that, in about a quarter of an hour, I saw first one *Callidina*, and then another, stretch its proboscis out of a cup, unfurl its wheels, and begin to feed.

No wonder that these *Philodinadæ* are to be found everywhere when they can bear to be frozen alive in the cell of a plant, or wasted by a midsummer sun in a leaden gutter!

Some chance breeze must have first wafted a *Callidina's* egg on to the scale-moss, just after a shower, when the whole plant was wet, and the little green cups were filled with water. The young *Callidina*, when hatched, could not have desired a better home. The rainfall, on an elm, flows down its furrowed bark in tracks as constant as those of a river and its tributaries; and the growth of the *Jungermann* follows these tracks. Every shower fills the spaces between its flat layers of overlapping leaves with water; and the lower layers, sheltered by the upper, retain for a long time water enough for the *Callidina* to creep about or swim in. And when, at last, the sun and air have dried up the water, the creature retreats into its green cup, which presents so small an aperture to the air, and is so fenced round with thick juicy cells, that the contained water is almost certain to hold out till the next shower. If it does not, the *Callidina* is still content; it becomes conscious of the coming crisis, draws in its head and foot, rounds its trunk into a ball, secretes round itself a gelatinous covering, and waits for better times.

But the Rotifera owe their wide dispersion not only to the ease with which their eggs are blown from one place to another, but also to their powers of endurance, and to their marvellous capacity for adapting themselves to new surroundings. A Philodine may say with Howell, "I came tumbling out into the world a true cosmopolite." I have already noticed how the *Philodinadæ* will endure such extremities of heat, cold, and dryness as Nature inflicts on them; but she does not put their full powers to the test, for, when time is given to them to don their protective coats, they can bear a heat gradually advancing to 200° F., or a fifty days' exposure to a dryness produced over sulphuric acid in the receiver of a good air-pump. Ehrenberg tells us that, whereas he killed *Volvox globator* with one electric shock, it took two of the same intensity to kill *Hydatina senta;* and that *Rotifer vulgaris* will swallow laudanum and yet "be lively," adding that a solution of cantharides seemed "to give it new life." The same irrepressible creature will flourish in water containing a perceptible quantity of sulphuric acid, while *Asplanchna priodonta* will swim about actively for twenty-four hours in a weak solution of salicylic acid, and *Synchæta pectinata* will do the same in chromic acid. The great majority of the fresh-water species die when dropped into sea-water, but some will bear sudden immersion in a mixture of one part sea-water to two fresh. We should not be surprised, therefore, to find not only that there are thirty-four known marine species of Rotifera, but that seventeen of these species are to be met with alike in salt-water and in fresh.

The following is the list of Rotifera found in salt or brackish water; those marked with a star are also the inhabitants of fresh-water:—

Floscularia campanulata*	Colurus amblytelus
Melicerta tubicolaria*	,, caudatus*
Rotifer citrinus*	,, dactylotus
Synchæta baltica	,, pedatus
,, tremula (?)*	,, uncinatus*
Pleurotrocha leptura (?)*	Mytilia tavina
Notommata naias*	Pterodina clypeata
Proales decipiens*	Brachionus Bakeri*
Furcularia forficula*	,, Mülleri
,, gracilis*	Notholca striata*
,, Reinhardti	,, spinifera
Diglena catellina*	,, inermis
,, grandis*	,, scapha*
Distemma raptor	,, thalassia
,, marinum	Anuræa valga*
Rattulus calyptus	,, biremis
Monostyla quadridentata	Hexarthra polyptera.

Although this is doubtless a very imperfect list, still it is sufficient to show how these fresh-water animals are slowly spreading into the tide-pools on the sea-shore. Some may have commenced their change of habitat in the field drains which are periodically invaded by the brackish waters of a tidal river. It was precisely in such a locality that I first found *Brachionus Mülleri*, in water only faintly salt, and at a height of 30 feet above the Severn. Ditches of this kind are to be found all down the Avon; from the highest point, that the tide reaches, to its mouth. As they approach the Severn their water becomes more and more brackish, and the preponderance of marine species in them more pronounced; so that it is easy to see how the descendants of a fresh-water Rotiferon, passing slowly down the river-side from ditch to ditch, may in course of many generations come to endure the sea itself.

In other cases the air-borne eggs may have dropped into the pools, of every degree of brackishness, which usually skirt the shores of our river estuaries. It is in such places, on the Scottish shore, that Mr. John Hood has found so many new marine species, and where no doubt so many more are yet to be found.

But the most noteworthy point about the above list is that the number of distinct genera is so great. One would rather have expected to find but four or five genera hardy enough to endure salt water; and yet here are no fewer than nineteen genera for the thirty-four known marine species; and of these latter, seventeen species are yet in the transitional state, inhabiting alike salt waters and fresh. Still more curious is it to find that all the four orders are represented; and that *Rhizota*, *Bdelloida*, and *Scirtopoda* have each furnished a contingent to the marine forms, as well as the more frequent *Ploima*. It is, of course, rather startling to hear that *Melicerta* and *Floscularia* are to be found inhabiting sea-water; but I know of no reason why any doubt should be thrown on Dr. Weisse's record of having so found them on the sea-shore at Hapsal.

The capacity of the Rotifera for adapting themselves to new surroundings is shown by a mere enumeration of the

strange places in which they are found. For these fresh-water creatures, the common inhabitants of lakes and ponds, are to be found in brackish ditches, sea-pools, the mud of ponds, the dust of gutters, in tufts of moss, on the blades of wet grass, in the rolled-up leaves and in the cups of liver-worts, in the cells of *Volvox*, the stems and sporangia of *Vaucheria*, in vegetable infusions; on the backs of *Entomostraca*, on their abdominal plates, on their branchial feet; on fresh-water fleas, wood-lice, shrimps, and worms; in the viscera of slugs, earth-worms, and Naiades; and in the body-cavities of *Synaptæ*.

But the great variability of every part of the external and internal structure of the Rotifera points to their fitness for playing the parts of cosmopolites. See how in *Floscularia* and *Stephanoceros* the head and its appendages are so developed that they dwarf all the rest; how in *Apsilus* the trunk predominates; while in *Actinurus* both head and trunk become appendages of a huge foot. The corona diminishes continually from the large complex organs of *Melicerta*, *Hydatina*, and *Brachionus*, down to the furred face of *Adineta* and the tuft of *Seison*, and vanishes altogether in *Acyclus*. The antennæ can be traced from long infolding or telescopic tubes, furnished with setiferous pistons, special muscles, and nerves, through a succession of shorter and simpler structures, till they become mere pimples or even setiferous pits in the body surface. The skin is hardened into a perfect lorica in *Brachionus*, is partially hardened in *Dapidia*, is merely tough in *Mastigocerca*, and is soft and quite unarmed in *Notommata*. The appendages of the body in Pedalion rise almost to the dignity of crustaceous limbs, for they have joints, and are worked by opposing pairs of muscles, passing across their cavities from point to point. In *Asplanchna* these appendages become stumpy projections, and the muscles, though still passing freely across the body-cavity, are reduced to threads. In *Triarthra* the appendages become chitinous spines; and at last, when we reach *Adineta*, *Taphrocampa*, and *Albertia*, we find that we have passed from a Rotiferon closely resembling a Nauplius-larva to one that is a simple worm.

The internal structure is just as plastic. The characteristic trophi exhibit a series of striking changes as we pass from one genus to another. In one direction the change is due to the degradation of the mallei, in the other to that of the incus; and in both this degradation is pushed so far, that the changing parts may be said almost to disappear. For in *Brachionus* and *Euchlanis* the mallei are well developed; in *Furcularia*, mere needle-shaped curved rods: in *Asplanchna*, so evanescent that it is hardly possible to find them in an animal killed by pressure.

By another set of changes, the rami are in their turn reduced almost to evanescence; becoming feeble loops in *Stephanoceros*, and in *Floscularia* two membranes attached to the unci.

Changes, great in degree, if not in variety, occur also in the excreto-respiratory system. For the contractile vesicle, which fills quite half the body-cavity in some *Asplanchnæ*, dwindles down in various species till it seems to vanish in *Pterodina* and *Pedalion;* while in one abnormal form, *Trochosphæra*, the connection between the lateral canals and the contractile vesicle is snapped, and the latter becomes an appendage of the cloaca only.

The nervous system, wherever it has been made out, is indeed always on the same plan; but its central organ, the nervous ganglion, is, in *Copeus* and *Euchlanis*, a great cylindrical sac stretching from the head below the mastax; while in *Floscularia* it shrinks into a small star-shaped body between the eyes and the organ of taste.

The alimentary and reproductive systems are those which vary the least; but even here the difference, in proportionate size, is very great between the stomachs of *Sacculus* and *Synchæta*, and also between the ovaries of *Asplanchnopus myrmeleo* and *Asplanchna priodonta*.

But not only do most of the external parts and internal organs vary in turn almost to vanishing, but these variations are not in any way simultaneous. The result is, that we find an organ, of a form characteristic of one family or genus, occurring in a species that belongs to another. Thus, for instance, the trophi of the *Melicertadæ* appear in *Pompholyx*, one of the *Triarthradæ*. Nay, more; it is easy to point out Rotifera that bear some striking characteristics of two or three other genera, or even of two or three other families. *Microdon clavus*, for example, has the central mouth and double ciliary wreaths of one of the *Rhizota*, the eye of a *Notommata*, the trophi of a *Diglena*, and the foot of a *Monostyla*. Again, *Pterodina patina* has the corona of *Philodina*, the lorica and transversely wrinkled retractile foot of *Brachionus*, the foot-ending of a young Rhizotan, and the mastax of the *Melicertadæ*. Then there is Mr. Thorpe's new Australian Floscule, which swims freely like one of the *Ploïma*, has the buccal cup and wreath of *Floscularia*, the dorsal eye of *Notommata*, and the body and forked foot of *Proales*.

To sum up, we may say that in the female Rotifera, the corona, head, foot, toes, appendages of the trunk, antennæ, eyes, and contractile vesicle vary down to almost absolute extinction; while, if we include the male in our survey, we must add that even the whole of the alimentary tract may disappear also. Moreover, the characteristics of the various groups interlace in so many ways that no organ—nor, indeed, any combination of two or three organs—can be relied upon to determine with certainty an animal's true position.

Two conclusions are, in consequence, irresistibly forced on us: the first, that the Rotifera, from *Pedalion* to *Albertia*, are related by descent; the second, that their curious habitats, wide dispersion and great variations in their structure are due to causes that have been at work for a very long period of time.

One other fact has also been made clear in this review—namely, that the British Rotifera give a very fair idea of the whole class. No doubt there are many foreign species, and some of these are very remarkable, and of great interest; but the greater number fall readily enough into the divisions that contain our own species.

And indeed it is a fortunate thing that we can here, at our own doors, study so many typical forms from life. For what books or drawings can give us the delight which we derive from observing the animals themselves?

To gaze into that wonderful world which lies in a drop of water, crossed by some atoms of green weed; to see transparent living mechanism at work, and to gain some idea of its modes of action; to watch a tiny speck that can sail through the prick of a needle's point; to see its crystal armour flashing with ever-varying tint, its head glorious with the halo of its quivering cilia; to see it gliding through the emerald stems, hunting for its food, snatching at its prey, fleeing from its enemy, chasing its mate (the fiercest of our passions blazing in an invisible speck); to see it whirling in a mad dance to the sound of its own music, the music of its happiness, the exquisite happiness of living,—can anyone, who has once enjoyed this sight, ever turn from it to mere books and drawings, without the sense that he has left all Fairyland behind him?

THE DARKNESS OF LONDON AIR.

A GREAT deal has been written at various times upon the subject of London fogs.

The constitution of these London fogs has been carefully gone into by several well-known men of science, from time to time; and the results obtained are of very great interest, as they prove, amongst other things, that during the winter London air has an unusually large amount of

carbonic acid in it. Dr. W. J. Russell found from experiments made in the City of London a few years ago, that on one day the carbonic acid had increased to 14·1 parts in 10,000 of air—that is, there was more than three and a half times the average amount present.

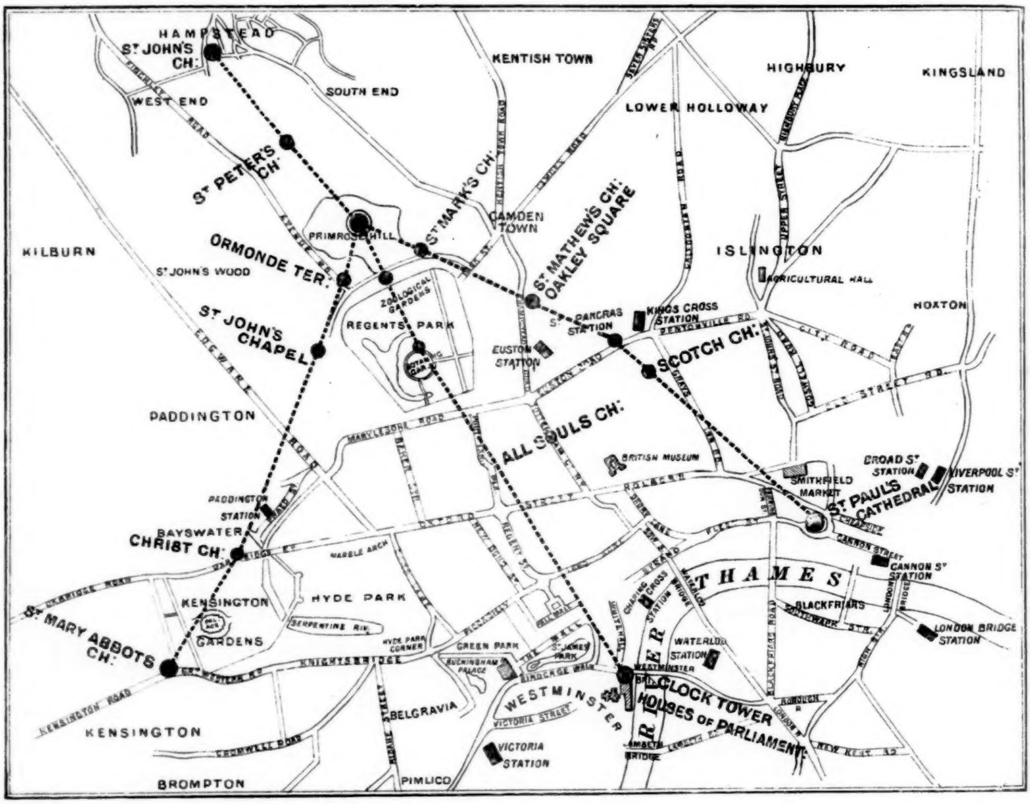
The question will naturally be asked, whether we cannot check this increase of carbonic acid in London air; and, in reply, it may be said that we can; partly by stopping the enormous volumes of sooty smoke belched out daily from hundreds of thousands of chimneys in the metropolis; and, partly, by having more open spaces, &c.

It is well known that the crowding of many people and animal life of all sorts, upon a small area of land, increases the production of carbonic acid, whether it be from respiration or from coal-burning; and it is almost indisputable that the latter produces the well-known black fogs and yellow fogs.

That these black fogs and yellow fogs—to which London and other large towns are liable in the winter—have a most injurious effect upon human beings and all animal life, and vegetation also, cannot be doubted, since we see the death-rate largely increased during the prevalence of black fogs; and of late years the more delicate plants, and indeed the strong ones, both at the Botanical Gardens, Regent's Park, and at Kew, have suffered much from the same cause.

Two things are to be briefly shown in this paper: (1) the general thickness and density of the atmosphere

SKETCH MAP OF A PORTION OF LONDON:—MEASURING POINTS SHOWN BY BLACK DOTS.



over London during the winter; and (2) the amount of artificial light used during the prevalence of black or dark yellow fogs in various parts of London.

In connection with this subject various observations were taken in London during the winter of 1887–88, and the results are given below.

Before proceeding further, we may note that London was very free from fogs during the winter of 1887–88—a fact which was probably, to a certain extent, due to the light rainfall, and the unusual dryness, in consequence, of the great plain or valley of the Thames. This was the case not only in London, but in Manchester, Leeds, Liverpool, and elsewhere.

(1) As regards the general thickness and density of London air. The sketch plan of a portion of London will show that Primrose Hill—which is about 219 feet above the sea-level—was the point selected for (let us say) measuring from.

Three lines, which embraced the measuring points fixed upon, were taken over London, these lines being respectively the south-west line to St. Mary Abbot's Church, Kensington; the south line to the Clock Tower, Houses of Parliament; the south-east line to St. Paul's Cathedral. One more line was taken towards the country: this we will call the north line to St. John's Church, Hampstead. Intermediate measuring points were taken on all these lines, church spires or towers, &c., being selected as the most conspicuous objects that could be seen from Primrose Hill.

The distance of all these intermediate measuring points

from Primrose Hill, and their names, are given in Table I. The *total* number of times that each of the chosen points was seen during the five months selected is also given.

It will be observed that during the 152 days which make up the five months selected, Christ Church, Lancaster Gate, and St. Mary Abbot's Church, Kensington, on the south-west line; the Clock Tower, Houses of Parliament, on the south line, and the Scotch Church, Regent's Square; and St. Paul's Cathedral, on the south-east line, were *never once* seen.

When it is known that on any ordinary fine day during the late spring, summer, and early autumn, you can see right across London, on any one of the selected lines, it will be easy to realize how thick the air over London is during the winter.

It may be noted that when you could see as far as St. John's Church, Hampstead, it would, as a rule, have been possible to see much further, but since there was no point beyond Hampstead which could be taken as a measuring point, it was impossible to record the distance.

(2) As regards the amount of artificial light used in various parts of London owing to the prevalence of dark fog. The observations given below were made, with the assistance of various friends, during the winter of 1887-88, and give the approximate result in hours.

TABLE I.—*The distances given in this Table are all measured approximately from Primrose Hill.*

	South-west line to St. Mary Abbot's Church, Kensington.				South line to the Clock Tower, Houses of Parliament.				South-east line to St. Paul's Cathedral.					North line to St. John's Church, Hampstead.	
Distance from Primrose Hill.	¼ mile.	¾ mile.	2 miles.	3 miles.	¼ mile.	¾ mile.	1¾ mile.	5 miles.	¼ mile.	1 mile.	1½ mile.	1¾ mile.	3¼ miles.	¾ mile.	1½ mile.
Name of Measuring Point.	South end of Ormonde Terrace.	St. John's Chapel, Marylebone.	Christ Church, Lancaster Gate.	St. Mary Abbot's, Kensington.	North side of Zoological Gardens.	North side of Botanical Gardens.	All Souls' Church, Langham Place.	Clock Tower, Houses of Parliament.	St. Mark's Church, Regent's Park.	St. Matthew's Church, Oakley Square, N.W.	Clock Tower, St. Pancras Station.	Scotc Church, Regent's Square.	St. Paul's Cathedral.	St. Peter's Church, Belsize P. rk.	St. John's Church, Hampstead.
November 1887	11	13	0	0	10	14	0	0	19	6	0	0	0	12	9
December 1887	18	13	0	0	17	13	0	0	25	4	1	0	0	8	11
January 1888	18	8	0	0	17	9	1	0	25	1	0	0	0	6	2
February 1888	5	22	0	0	3	24	0	0	22	3	2	0	0	3	21
March 1888	31	31	0	0	31	30	1	0	30	1	0	0	0	8	23
Total number of times each point was seen... ...	83	87	0	0	78	90	2	0	121	15	3	0	0	37 [1]	66

On nine days you could not see 100 yards. On four days you could not see 5 yards.

A few districts out of many others are given in Table II.

TABLE II.—*Observations taken in London.*

District in London in which the register was kept.	1887.		1888.			Total number of hours during which artificial light was used.
	Nov.	Dec.	Jan.	Feb.	March.	
Fenchurch Street, E.C.	13½	1¾	29	0	3½	47¾
Southwark Street, S.E.	27¼	1½	20½	0	2¼	51½
Grosvenor Gardens, S.W. ...	17¾	0	35	0	2½	55¼
Oakley Square, N.W.	19½	5	13	0	3	40½
New Cavendish Street, W. ...	23½	2	26	0	1½	53
Notting Hill Gate, W.	19	0	15	0	2¼	36¼
Homerton, E. ...	34¼	24¼	38¼	4¾	11½	113

The manner in which the observations (given in Table II.) were made will be seen in detail from Table III., which was kept by Mr. E. Liddell at the College, Homerton, E.

This table is given because Homerton suffered more from darkness than any other part of London, owing, it cannot be doubted, to the large number of factories in the neighbourhood. It will be seen later on in this paper that Leeds suffered more from darkness than the other provincial towns selected, and this was due probably to a great extent to the same cause.

From Table II. it will be seen that January was the worst month for dark fogs, the average for each of the districts given being 27 hours of darkness per month.

London is not much worse than our large provincial towns in respect to dark fogs. Table IV. gives the results of observations made in several towns.

It will be seen from Table IV., that dark fog was general in the tabulated towns during the month of January. It is said that Manchester, of late years, has been unusually free from dark fogs, owing to the fact that a very large number of mills have been moved out, so as to escape the heavy town rates, &c. The ordinary white fog has also been reduced, probably through thousands of acres of the wet morass lands on the west side of Manchester having been well drained recently. This being

[1] On thirty-six days this point could not be seen.

the case, something might be done to improve the drainage of the marshes to the east of London.

Presuming that dark fogs are principally due to smoke, —and Sir Douglas Galton, in a paper read at the Parkes Museum in 1887, on "The Cause and Prevention of Smoke," declared that black (or dark) fog was *entirely* the result of smoke, while Dr. Marcet attributes the density of London fog *mainly* to smoke—it is clear that we want legislation to intervene, and to extend the Metropolitan Acts of Parliament, viz. those of 1853 and 1856, and instead of allowing these Acts to deal only *partially* with factory smoke, to cause them to be applied to every house in London.

TABLE III.—*Fog Observations from November* 1, 1887, *to March* 31, 1888.

NOTE.—Two spaces will be found below for every day during the five months. When, owing to the prevalence of fog, artificial light is used on a particular day, put a × in the *first* space assigned to that particular day; and in the *second* space put the quarters of an hour or number of whole hours and quarters during which light is used.

	November.		December.		January.		February.		March.	
	Denote days by ×.	Duration of time in hours.	Denote days by ×.	Duration of time in hours.	Denote days by ×.	Duration of time in hours.	Denote days by ×.	Duration of time in hours.	Denote days by ×.	Duration of time in hours.
1	...	...	×	1½						
2	...	...	...	...	...	...	×	4¾		
3	...	...	...	...	×	1				
4										
5										
6										
7										
8	...	...	×	2¼						
9	...	...	...	...	×	1				
10	....	...	×	2	×	8				
11	...	...	×	5½	×	8				
12	...	...	×	4	×	5½				
13	...	...	×	1½	×	4				
14	...	...	...	...	×	2¼				
15										
16	×	9¼								
17										
18	×	8								
19	×	2½								
20	×	1¼	...	...	×	4½				
21	×	6¼	...	...	×	2				
22	×	2¼	...	...	×	½				
23	...	...	...	...	...	...	...	...	×	6[1]
24	×	1½								
25										
26	...	...	...	...	...	...	...	...	×	1[2]
27	...	...	...	...	...	...	...	...	×	4½[3]
28	×	1								
29	×	2¼								
30	...	...	...	...	×	1				
31	...	...	×	7½						
		34¼		24¼		38¼		4¾		11½

Grand total = 113 hours.

TABLE IV.—*Observations taken in Provincial Towns.*

Name of Town in which the register was kept.	1887.		1888.			Total number of hours during which artificial light was used.
	Nov.	Dec.	Jan.	Feb.	March.	
Leeds	18½	12	47	4	0	81½
Liverpool	6½	8¼	26¼	3¾	0	44¾
Manchester ...	16	20	37	0	3	76

[1] Fog not dense on March 23, but very dark.
[2] Darkness, rather than fog, from 2.45 to 3.40.
[3] Fog and darkness.

It is not necessary to quote any figures here, to prove how the death-rate in London rapidly increases during the prevalence of smoke fogs, as everyone knows it too well. But we may give an extract from the *Gas World* to show the enormous and quite unnecessary cost of these smoke fogs.

The *Gas World* says that, "during the foggy days which were experienced between the 16th and 24th of November 1887, the Gas Light and Coke Company sent out to its customers in London no less than 710,251,000 cubic feet of gas; that to manufacture this quantity 71,000 tons of coal must have been carbonized, and that the total value of the gas, without the consideration of the by-products, is £106,000. During the nine days, therefore, the public paid the Gas Light and Coke Company no less than £490 per hour for *artificial light.*"

This calculation, it should be observed, does not include the amount supplied by other Gas Companies in London during the same short period of fog.

W. HARGREAVES RAFFLES.

ELECTRICAL STRESS.[1]

THE subject of the discourse was brought before the members of the Royal Institution some years ago by Mr. Gordon. In the interval a considerable amount of work has been done upon it, both in England and Germany, and many experiments have been devised to illustrate it. Some of the more striking of these, though of great interest to the student, are rarely or never shown in courses of experimental lectures. The lecturer and Mr. C. V. Boys, F.R.S., last year devised a set of apparatus which has made the optical demonstration of electrical stress comparatively easy, and most of the results obtained by Kerr and Quincke can now be demonstrated to audiences of a considerable size. Before discussing this portion of his subject the lecturer introduced it by an explanation of principles on which the experiments are founded.

Magnetic lines of force can easily be mapped out by iron filings, but the exhibition of electrical lines of force in a liquid is a more complex matter. In the first place, if two oppositely electrified bodies are introduced into a liquid which is a fairly good non-conductor, convective conduction is set up. Streams of electrified liquid pass from the one to the other. The highly refracting liquid phenyl thiocarbamide appears to be specially suitable for experiments on this subject. If an electrified point is brought over the surface a dimple is formed which becomes deeper as the point approaches it. At the instant at which the needle touches the liquid the dimple disappears, but a bubble of air from the lower end frequently remains imprisoned in the vortex caused by the downward rush of the electrified liquid from the point. It oscillates a short distance below the point, and indicates clearly the rapid motions which are produced in the fluid in its neighbourhood. When the needle is withdrawn a small column of liquid adheres to it. This effect is, however, seen to greater advantage if a small sphere about 5 mm. in diameter is used instead of the needle-point. When this is withdrawn a column of liquid about 5 mm. high and 2 mm. in diameter is formed between the sphere and the surface. A similar experiment was made by Faraday on a much

[1] Abstract of a Lecture delivered at the Royal Institution on February 15, by Prof. A. W. Rücker, F.R.S.

larger scale with oil of turpentine, and he detected the existence of currents, which are in accord with the view that the unelectrified liquid flows up the exterior of the cylinder, becomes electrified by contact, and is repelled down its axis. In view of this explanation, and the movements assumed can be clearly seen in the phenyl thiocarbamide, the performance of the experiment on a small scale is not without interest. The possibility of the formation of such violent up-and-down currents in so small a space must depend upon a very nice adjustment between the properties of the liquid and the forces in play. It is obvious that such movements of the liquid must be a disturbing element in any attempt to make the lines of electric force visible.

Again, if a solid powder be suspended in a liquid into which electrified solids are introduced, it tends to accumulate round one of the poles. This subject has been investigated by W. Holtz. Sometimes the powder appears to move in a direction opposed to that in which the liquid is streaming. Sometimes two powders will travel towards different poles.

If powdered antimony sulphide be placed in ether, it settles at the bottom of the liquid, and if either two wires insulated with glass up to their points, or two vertical plates be used as electrodes, on exciting them slightly the solid particles arrange themselves along the lines of force. If the electrification be increased, they cluster round the positive pole. On suddenly reversing the electrification by means of a commutator, they stream along lines of force to the pole from which they were previously repelled. Other methods of obtaining the lines of force have been devised. They can, for instance, be shown by crystals of sulphate of quinine immersed in turpentine.

The tendency of the lines of force to separate one from the other was illustrated by Quincke's experiment. A bubble of air is formed in bisulphide of carbon between two horizontal plates. It is in connection with a small manometer, and when the plates are oppositely excited, the electrical pressure acting at right angles to the lines of force, being greater in the liquid than in air, compels the bubble to contract.

Kerr's experiments depend upon the fact that, since the electrical stress is a tension along the lines of force, and a pressure at right angles to them, a substance in which such a stress is produced assumes a semicrystalline condition in the sense that its properties along, and perpendicular to, the lines of force are different. Light is therefore transmitted with different velocities according as the direction of vibrations coincides with, or is perpendicular to, these lines; and the familar phenomena of the passage of polarized light through crystals may be imitated by an electrically stressed liquid.

The bisulphide of carbon used must be dry, and, to make the phenomena clearly visible, it is necessary that the light should travel through a considerable thickness. Thus, to represent the stress between two spheres, elongated parallel cylinders should be used, the axes of which are parallel to the course of the rays of light. These appear on the screen as two dark circles. Between crossed Nicols, the planes of polarization of which are inclined at 45° to the horizontal, the field is dark until the cylinders are electrified, when light is restored in the space between them.

If parallel plates with carefully rounded edges, and about 2 millimetres apart, are used, the colours of Newton's rings appear in turn, the red of the third order being sometimes reached. If one plate is convex towards the other, the colours of the higher orders appear in the middle, and travel outwards as the stress is increased. The experiments may be varied by using two concentric cylinders, or two sheets of metal bent twice at right angles to represent a section through a Leyden jar. In the first case a black cross is formed; and in the second, black brushes unite the lower angles of the images of the edges of the plates. By the interposition of a piece of selenite, which shows the blue of the second order, two of the quadrants contained between the arms of the cross become green, and the others red. In like manner the horizontal and vertical spaces between the inner and outer coatings of the "jar" become differently coloured.

There are several phenomena connected with the stress in insulators which present considerable difficulties. Thus in a solid it is found impossible to restore the light between crossed Nicols by a uniform electrical field. That the non-uniformity of the field has nothing to do with the phenomenon in liquids, though at first disputed, is now generally admitted. It may be readily proved by means of a Franklin's pane, of which half is pierced into windows. The glow is much weakened by thus removing part of the uniform field, though it is thus made much less uniform.

Again, though most dielectrics when placed in an electric field expand, the fatty oils contract. Prof. J. J. Thomson has recently pointed out that this indicates that another set of strains are superposed upon those assumed in the ordinary explanations of these phenomena, and by which they may be neutralized or overcome.

In experiments with carbon bisulphide it is necessary to take every precaution against fire. For this purpose the cell which contains the liquid should be immersed in a larger cell, so that if—as sometimes happens—the passage of a spark cracks the glass the liquid may flow into a confined space. This should stand in a tray with turned-up edges, and an extinguisher of tin plate should be at hand to place over the whole apparatus. No Leyden jars should be included in the electrical circuit. The difficulties which formerly arose in the exhibition of experiments in statical electricity owing to the presence of moisture in the air of a lecture-room are now immensely reduced by the Wimshurst machine, which works with unfailing certainty under adverse conditions. A new and very beautiful machine was kindly lent by Mr. Wimshurst for the purposes of the lecture.

NEW BUILDINGS AT CAMBRIDGE FOR PHYSIOLOGY AND ANATOMY.

THE energy and success of the Cambridge teachers of science are once more demonstrated by the proposal to build new laboratories, with a large lecture-room, for anatomy and physiology, and a museum and dissecting-room for human anatomy, on a scale commensurate with the importance of the medical and biological school. The present physiological laboratories, which ten years ago were a great advance upon the mere make-shift arrangements that had previously done duty, are now disagreeably overcrowded. At present, Prof. Foster's elementary class is attended by between 190 and 200 students; and the several advanced classes have from twenty to thirty-five students. In the laboratory there are now only places for ninety students of histology; but accommodation has been provided for about seventy more in a temporary building attached to the museum. Inasmuch as the students of the elementary class must all go through the histological course, lasting throughout three terms, it is evident that they can be accommodated only by relays, and that in order to accommodate the advanced students, who have no proper places of their own, much crowding must take place, whereas the advanced students' work-places ought not to be disturbed, as these students need opportunities for continuous work. For chemical physiology there are only eight places available, and there is one fairly large room for physical physiology; there is no adequate lecture-room.

The proposed buildings have once been deferred, plans having been prepared in 1884; but it is hoped that the

delay may have led to the presentation of a better and more complete plan. The details of the scheme would be too long for us to give; but the result will be to provide an excellent new building extending for 190 feet along Corn Exchange Street, in continuation of the east front of the present buildings for physiology and comparative anatomy, and occupying the whole distance between them and the Corn Exchange. Besides rooms for teachers and demonstrators, aquaria, and preparation-rooms, there will be a new class-room in which 140 additional students for histology can be accommodated. There will be a demonstration-room in which about fifty students at a time can be shown experiments which now have to be omitted owing to the want of such a room. By rearrangement of rooms additional accommodation will be given to chemical physiology and to research, while rooms will be available for advanced students to work without interruption from the elementary classes.

The new lecture-room will be in the middle block, between the anatomical and physiological buildings; internally it is to measure 40 by 45 feet, by 25 feet high to the wall-plate, above which will be an open queen-post trussed roof, with sky-lights in the sides. There will also be a large window in the east gable. This lecture-room will accommodate 240 students, for more than which number it is not yet considered necessary to provide; although if the school continues to expand till it reaches the dimensions of the Edinburgh School, which is not impossible, a still larger lecture-room will ultimately be required. But the present proposal will give a room far superior to the room now in use, both for anatomy and physiology.

The northern block, for human anatomy, has about 70 feet of frontage, and contains, in addition to offices, Professor's and articulating-rooms, &c., a museum 40 feet by 60, lighted by windows in three walls, and 17 feet high, admitting of the construction of a gallery. Above the museum is a dissecting-room of rather larger area, well lighted.

The estimated cost is, for physiology, £4755; lecture-room, £3338; human anatomy, £5872: total, £13,965. The report and plans are to be discussed on Saturday next, and we hope they will be promptly carried out, as the anatomical buildings at present in use are painfully inadequate, and physiology is also urgently in need of better accommodation.

NOTES.

THE subject of the Croonian Lecture to be delivered before the Royal Society during the present year will be "Preventive Inoculation." The lecture will be delivered by M. Roux, and will be founded on observations made in the Pasteur Institute. It is hoped that M. Pasteur will be present at the lecture.

MR. EADWARD MUYBRIDGE, of Philadelphia, who by arrangement with the Managers of the Royal Institution had agreed to give a discourse after Easter on "The Science of Animal Locomotion in its Relation to Design in Art" (illustrated by the zoopraxiscope), a subject of great novelty and interest, has kindly consented to deliver it on Friday evening, the 22nd instant, Dr. Edgar Crookshank being compelled, through illness, to defer his discourse on "Microbes," which was to have been delivered on that evening.

To meet the expressed wish of the members, the Council of the Mineralogical Society has resolved that two additional general meetings shall be held in London during the current year; the first has been fixed for Tuesday, March 12, and the other for Tuesday, June 25. The general meetings still to be held in London during the year will thus be on the following Tuesdays: March 12, May 7, June 25, November 5 (anniversary). The meetings will be held on the premises of the Geological Society, Burlington House, Piccadilly, at 8 p.m.

ON Monday, March 11, Mr. William Jago will begin, at the City and Guilds of London Institute, a course of ten lectures on "Bread-making." The lectures will be delivered on Monday and Thursday evenings at 7.30. The special object of the course is to give, in the simplest possible manner, instruction to practical working bakers as to the nature of the changes which occur during the manufacture of bread.

IN spite of the enthusiasm evoked in Norway by the success of the Nansen Expedition, the national subscription opened to defray the cost has been but poorly responded to. In consequence, Herr Gamél, of Copenhagen, whose munificence enabled the Expedition to start at all, has offered to contribute the balance wanting.

WE regret to have to record the death of the Rev. John George Wood, author of "Common Objects of the Sea-shore" and many other popular works on natural history. He died on Sunday, while on a visit to Coventry, from an attack of peritonitis. Mr. Wood was in his sixty-second year.

THE death is announced of Dr. Johannes Brock, lately Professor of Zoology at Dorpat University. He was well known by his scientific journey to the Indian Archipelago, undertaken with the pecuniary help of the Berlin Academy. He died at Göttingen, where he had been appointed Professor of Natural Science.

DR. J. SOYKA, Professor at the German University at Prague, and formerly at the University of Munich, shot himself during a fit of melancholia, on February 23. He was the author of works on Bacteria.

LAST week, in answer to a question put by Mr. Mundella, with regard to the aid to be granted by the Government to provincial Colleges, the Chancellor of the Exchequer made the following statement:—"A vote for provincial Colleges has been put down in the Estimates for 1889-90. The Government have found considerable difficulty in deciding what Colleges should be entitled to share in it, and in what proportions and on what conditions it should be distributed between them. They have accordingly appointed a small Committee to make particular inquiries and advise them on these points. The Committee will sit at an early date, and its deliberations are not likely to be prolonged. Upon receiving its report the Government will settle the scheme of distribution. The sum voted will, of course, be available for the Colleges which are entitled to share in it during the coming financial year."

THE Owens College is one of the Manchester institutions which benefit by the will of the late Mr. John Rylands. He has bequeathed to it £10,000.

SOME time ago the Coast Fishing Section of the German Fisheries Society established a zoological station at Ditzum, on the Dollart, where researches on the fauna of the German Ocean were carried on during the summer months. The Society are now making arrangements to keep the station open during the whole year.

A BIOLOGICAL STATION, chiefly for the promotion of the fisheries, is to be established in Denmark, at a cost of £2000, with a yearly subsidy of £480.

THE Fisheries Exhibition which has just been opened in St. Petersburg is the first Exhibition of this kind that has been held there. It will remain open till the end of April.

ON February 20, about 10 p.m., a remarkably brilliant meteor was seen in and around Stavanger, on the west coast of Norway. It radiated in the south-east, and, going in a westerly direction, burst about 35° above the horizon, without any detonation, but leaving a long trail behind. Its light was a dazzling white.

ON January 22, about 2 a.m., an earthquake shock was felt at Hönefos, in Central Norway. This was followed by another, and by a few more at intervals, but faint in character.

A NUMBER of houses were destroyed by the earthquake that occurred at Fleurier, in the Jura Mountains, on February 13 last.

IN the *American Meteorological Journal* for December last, General Greely, Chief Signal Officer, contributes an interesting article on "Average Velocities of Low-area Storms and Upper Air Currents in the United States." The author shows that the decrease in velocity of the former is regular and unbroken from February to June, and that the increase is nearly as regular to February again. He expresses the important opinion that the average movement of low-area storms in the United States bears a definite relation to the velocity of upper air currents; and in support of this, a chart is given showing a remarkable accord between the mean hourly velocity of low-area storms and the mean velocity of the upper air currents from 1881–87. Prof. M. W. Harrington contributes a useful article in the shape of a translation of a simple demonstration of the deflection of horizontal motion due to the earth's rotation, from Dr. Günther's "Lehrbuch der Geophysik," without the use of higher mathematics. In the January number, Mr. A. L. Rotch gives a very complete account of the organization of the meteorological service in France since the first establishment of weather telegraphs by Leverrier at the Paris Observatory in 1856, together with descriptions of the instruments and methods now employed. Since 1887 the meteorological service has been separated from the astronomical work, and has been under the able direction of Prof. E. Mascart. The observing-station of the Central Office is the Parc St. Maur Observatory, nearly ten miles south-east of Paris.

IN the latest Report of the Bombay Chamber of Commerce, it is stated that it was decided by the Government last May to abolish the office of Meteorological Reporter of Western India, and substitute for it that of Reporter at a reduced salary, who would work under and through the Meteorological Office at Simla. The Chamber, thinking that this alteration would be detrimental to the shipping in the port by stopping the system of storm-warnings that had been carried on for some years, petitioned the Government against the proposed change, and advocated the establishment of additional coast and inland signal stations to aid in the daily forecasts. The Chamber also pointed out in its petition that its members have, for a number of years, printed bi-weekly weather reports, which were indispensable in the absence of a Government daily weather chart and report. The Superintendent of the Meteorological Department of the Government of India was sent to Bombay to make inquiries, but his visit only resulted in the closing of the office in the month of August. Since that time the head of the Telegraph Department has superintended the forecasts. The scheme now about to be tried is that, in consideration of a small monthly payment by the Chamber of Commerce and the Port Trust, a daily telegraphic weather report chart and storm warnings and a bi-weekly crop report will be supplied to each member of the Chamber.

MR. R. ANDREE has lately been collecting information as to the use of signals by primitive peoples, and the facts he has brought together—summarized in *Science*—are interesting and suggestive. American Indians use rising smoke to give signals to distant friends. A small fire is started, and, as soon as it burns fairly well, grass and leaves are heaped on the top of it. Thus a large column of steam and smoke rises. By covering the fire with a blanket, the Indians interrupt the rising of the smoke at regular intervals, and the successive clouds are used for conveying messages. Recently, attention has been called to the elaborate system of drum-signals used by the Cameroon negroes, by means of which long messages are sent from village to village. Explorations in the Congo basin have shown that this system prevails throughout Central Africa. The Bakuba use large wooden drums, on which different tones are produced by two drum-sticks. Sometimes the natives "converse" in this way for hours; and, from the energy displayed by the drummers, and the rapidity of the successive blows, it seemed that the conversation was very animated. The Galla south of Abyssinia have drums stationed at certain points of the roads leading to the neighbouring States. Special watchmen are appointed, who have to beat the drum on the approach of enemies. Cecchi, who observed this custom, designates it as a "system of telegraphs." The same use of drums is found in New Guinea. From the rhythm and rapidity of the blows, the natives know at once whether an attack, a death, or a festival is announced. The same tribes use columns of smoke or (at night) fires to convey messages to distant friends. The latter are also used in Australia. Columns of smoke of different forms are used for signals by the inhabitants of Cape York and the neighbouring island. In Victoria, hollow trees are filled with fresh leaves, which are lighted. The signals thus made are understood by friends. In Eastern Australia, the movements of a traveller were made known by columns of smoke, and so was the discovery of a whale in Portland Bay.

A VERY important series of vapour-density determinations have been made by M. Alphonse Combes, which appear to decide the much-discussed question of the valency of aluminium. It will be remembered that a few months ago, as noticed in these columns (vol. xxxviii. p. 624), Profs. Nilson and Pettersson, of Stockholm, published the results of a most conclusive series of experiments upon chromic chloride, showing that at the lowest available temperature the density of the chloride corresponds so closely to the formula $CrCl_3$, as to preclude the possibility of the existence of molecules of Cr_2Cl_6 in the gaseous state. This decisive result in the case of chromium, following as it did after the experiments of Prof. Victor Meyer and Dr. Grünewald upon ferric chloride, which also resulted in showing that the formula $FeCl_3$ represented the only stable molecular condition, appeared to indicate that the metals of this group are really triads, and that the double formulæ Cr_2Cl_6 and Fe_2Cl_6 must be abandoned. This conclusion was further strengthened by the fact that still earlier determinations of the vapour-densities of the chlorides of indium and gallium by Prof. Meyer, Profs. Nilson and Pettersson, and M. Friedel, had yielded conclusive results, pointing to the formulæ $InCl_3$ and $GaCl_3$. In the case of aluminium, however, the evidence has been by no means so decisive. As shown by Dr. Young, in an admirable *résumé* of all the experimental data bearing upon this question in NATURE (vol. xxxix. p. 198), determinations of the vapour-density of aluminium chloride by Profs. Nilson and Pettersson showed that from 440° C. the density gradually diminished, until at about 800° it arrived at the value corresponding to $AlCl_3$, and then remained constant for about 200°, until, in fact, it began to break up with liberation of free chlorine. On the other hand, Messrs. Friedel and Crafts, in a beautifully graduated series of experiments, found that at 218°, 31° above the boiling point, the density corresponded almost exactly to the formula Al_2Cl_6, and remained practically constant to 400°. More recently, Messrs. Roux and Louïse have found that, at temperatures near their boiling-points, methide and ethide of aluminium possess densities corresponding to the formulæ $Al_2(CH_3)_6$ and $Al_2(C_2H_5)_6$; these values, however, do not remain constant for any sufficient interval of temperature, and so are by no means conclusive. At this interesting moment M. Combes brings forward his experiments upon a new compound, acetyl acetonate of aluminium, $[Al(C_5H_7O_2)_3]_n$, a

substance readily obtained perfectly pure as a white crystalline solid, melting at 193°–194°, and vaporizing unchanged at 314°–315°. Two consecutive density determinations by Victor Meyer's method in an atmosphere of nitrogen and at the temperature of boiling mercury, which is only 45° above the boiling-point of the substance, yielded numbers corresponding to the molecular weights 325·5 and 324·2. The molecular weight of $Al(C_5H_7O_2)_3$ is 324·5; so that, even at this comparatively low temperature, just as in the case of chromium chloride, the triad is the only possible formula. There was no trace of decomposition, the pure white crystals being found re-formed and chemically unchanged after the experiment. From this result it appears pretty conclusive that aluminium does behave like chromium, iron, indium, and gallium, and that, although in the case of the chloride, molecules of the composition Al_2Cl_6 may for a brief space exist, yet the most stable molecules of aluminium compounds in general are those in which the metal plays the part of a triad.

In some notes on a voyage to the Greenland Sea in 1888, published in the *Zoologist* for March, Mr. Robert Gray gives some curious particulars with regard to the contents of the stomachs of several hooded seals, *Cystophora cristata*, shot on July 9. While most were empty, one was packed full with a bluish mud or ooze, in which were embedded the crystalline lenses of two eyes belonging probably to some small species of fish, and the remains of one Crustacean common at the surface (*Themisto*). The stomachs of three other seals contained mud alone. "With regard to the presence of mud in these animals' stomachs," says Mr. Gray, "while considering the depth of the water too great (in this instance 200 fathoms; in another, 1100) to permit the bottom being reached, the only explanation I am able to offer is that the substance must be swallowed in small quantities by the seals along with their ordinary food (Crustaceans living at the surface), and that, owing to its indigestible nature, it accumulates in course of time in the stomach. These seals are occasionally observed disappearing under the ice, for the purpose, I believe, of feeding on the immense number of Crustaceans which are known to accumulate there. Many of the ice-fields bear on their surface, immediately under a superficial coating of snow, cargoes of mud (apparently of an alluvial origin). During the process of melting, the mud may accumulate on submerged tongues or ledges of the ice, and thus become the retreat of numbers of Crustaceans, which, as they are devoured by the seals, are swallowed along with a small quantity of the mud. Some such explanation must, I think, be conceived."

A paper on the occurrence of Pallas's sand-grouse (*Syrrhaptes paradoxus*) in Ireland was read some time ago before the Royal Dublin Society, by Dr. Robert Scharff, and has now been printed. The immigrations of the bird began in Ireland at the end of May and lasted to the middle of July, when they ceased until the end of November. It is difficult to say, with any degree of accuracy, how many specimens found their way to Ireland; but Dr. Scharff thinks that in the various flocks which were seen there may have been about one hundred birds. A far larger number, however, may not have been observed. "Following their instinctive desire to explore the extreme west," says Dr. Scharff, "hundreds may have perished in the waves of the Atlantic, thus putting a stop to their enterprising spirit."

An interesting paper on the Coreans was read lately by Mrs. E. R. Scidmore, an American lady who, in 1887, visited, as a guest, Judge Denny, the foreign adviser to the King of Corea. Wisps of straw and bits of cloth hang at the doorways to keep off evil spirits; and these, according to Mrs. Scidmore, are the only signs of worship seen about Seoul. The Coreans have the worship of ancestors, as the Chinese; and a trace of the old dragon-worship must order their toleration of snakes, as it is impossible to get a Corean servant to kill the snakes that drop from the mud roof and slip out of the flues of the kaugs that warm the floors of the houses. Until the arrival of the American physicians, the king and queen had an army of necromancers and wizards in attendance upon them, and a form of Shamanism was practised upon the sick. They were consulted also in matters of State policy.

A supplement to the first volume of the *Internationales Archiv für Ethnographie* has been issued. It consists of a careful and interesting monograph, by Dr. Otto Stoll, on the ethnology of the Indian tribes of Guatemala. He has much that is valuable and interesting to say about the social organization of these tribes, their religious ideas and customs, and their skill in various industrial arts. Two admirably coloured plates accompany the essay, and three illustrations are given in the text.

The January and February numbers of *Mathesis*, a Belgian mathematical journal, have just been issued as a single number of seventy pages, which are wholly taken up with a French translation of the "supplementary chapter" of Dr. Casey's "Sequel to Euclid" (pp. 165–248, fifth edition). With the double part the editors present a copy of M. Vigarié's useful "Premier Inventaire de la Géométrie du Triangle," to which we lately drew attention.

The proprietors of the Castle Mail steamers have issued a guide "to the land of gold and diamonds, and the places touched at by their various steamers." The book is called "South Africa, and how to reach it by the Castle Line." The author is Mr. Edward P. Mathers.

The additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus* ♀) from India, presented by Miss L. C. Hart; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Mrs. Margaret Allison; an American Black Bear (*Ursus americanus* ♂) from North America, presented by Messrs. Hugh Williams and Basevi, Lieutenants R.N.; a Common Fox (*Canis vulpes*), British, presented by the Lord Tredegar; a Short-eared Owl (*Asio brachyotus*), captured at sea, presented by Mr. R. Phillips; a Common Blue Bird (*Sialia wilsoni*) from North America, presented by Commander W. M. Latham, R.N.; an Axolotl (*Siredon mexicanus*) from Mexico, presented by Mr. E. Evelyn Barron; nine Moorish Geckos (*Tarentola mauritanica*) from the South of France, presented by Masters F. and O. Warburg; a Manatee (*Manatus australis*) from Guiana, deposited; two Tui Parrakeets (*Brotogerys tui*) from Brazil, four White-breasted Gallinules (*Gallinula phœnicura*) from India, purchased; an Unarmed Trionyx (*Trionyx muticus*) from North America, received in exchange.

OUR ASTRONOMICAL COLUMN.

Solar Activity in 1888.—The behaviour of the various orders of solar phenomena, spots, faculæ, and prominences, during the past year has shown most conclusively that the minimum must now be very near at hand, and it may with confidence be expected to fall either towards the end of the current year or else early in 1890. The spots especially have shown unmistakable signs that the trough of the eleven-year curve is nearly reached, for they have been few in number, small in size, and low in latitude, and there have frequently been considerable intervals in which no spots have been seen at all. The remarkable depression of October 31 to December 9, 1886 (see Nature, vol. xxxv. p. 445) has in some respects indeed not been equalled during 1888, but there has been no such long period of unbroken quiescence since the minimum of 1879 as that recorded in last October, when in the three weeks October 4–24 not a single spot was seen, whilst there were but three days showing spots in the thirty-seven from September 29 to November 5. Other spotless or nearly spotless periods in 1888 were January 23–30, February 4–17, March 1–8, March 24–31, April 6–15, April 30 to May 10,

May 24 to June 8, June 30 to July 12, July 18 to August 7, and December 22–31. And not only were there these long and numerous breaks in the spot manifestations, but when spots were seen they were almost always small in size and few in number. On not a single day in the year did the total spotted area amount to $\frac{1}{1500}$ of the surface of the visible hemisphere; on only eight days did it exceed $\frac{1}{2000}$. The mean daily spotted area for the year amounted only to about 9 parts in 100,000, or almost precisely the same as in 1877. In January there was a feeble but fairly sustained display of activity up to the 22nd; there was a similar but less lasting manifestation at the end of February, and again about the middle of March. April was very quiet, but May 11–23 yielded a fair show of spots, May 14 giving the largest area of the year. August 28 to September 9 was also a fairly active time; but the most prolific month as to entire spotted area, though not as to number of spots, was November, following immediately after the longest period of entire quiescence. The last ten days of last year, and the first two months of the present, have been exceedingly barren.

A rough tendency has manifested itself in the past as in previous years, for quiet intervals to follow each other at the distance of half a synodic rotation of the sun, indicating a preference of the spots for a few favoured longitudes. In latitude, the spots have continued to be more numerous in the southern hemisphere—a condition of things that has prevailed, on the whole, ever since the dying away of the great spot of November 1882. Generally speaking, the spots have lain close to the equator, not often rising above 5° or 6° of latitude in the northern hemisphere, and 9° or 10° in the southern; but the same curious pulsation shown in the great eleven-year cycle has been also visible in these minor oscillations, and whenever there has been anything like an outburst, there has also been an effort to ascend to higher latitudes. Thus, the greatest display in the northern hemisphere, that of November, lay in lat. + 11°; whilst a part of the outbreak in the southern hemisphere in September reached lat. –16°.

The monthly numbers for spots and faculæ given by Prof. Tacchini, in the *Comptes rendus*, vol. cvi. No. 18, vol. cvii. No. 6, and vol. cviii. No. 7, are as follows, and may be compared with those given for previous years in NATURE, vol. xxxiii. p. 398, vol. xxxv. p. 445, and vol. xxxvii. p. 423:—

	Relative frequency of days without spots.	Sun-spots. Relative frequency.	Sun-spots. Relative size.	Sun-spots. Mean daily number of groups.	Faculæ. Relative size.
January	0·21	2·70	11·17	1·30	14·13
February	0·74	2·30	5·91	0·48	11·09
March	0·61	1·70	6·22	0·48	14·57
April	0·39	1·65	4·31	0·89	13·65
May	0·54	2·50	18·77	0·46	7·20
June	0·42	3·71	4·18	0·79	17·52
July	0·68	1·10	3·45	0·42	15·81
August	0·46	1·86	13·71	0·68	14·29
September	0·04	4·80	40·12	1·68	27·80
October	0·80	0·68	1·12	0·08	5·72
November	0·41	3·12	21·88	0·77	9·12
December	0·44	2·44	10·64	0·56	10·22

The foregoing table shows that the faculæ have not by any means varied simultaneously with the spots, and that their diminution as compared with 1886 and 1887 has been but slight. They showed, however, a very noticeable development during the secondary maximum of September, whilst the prominences, on the other hand, fell off considerably both in September and November, but attained their greatest development during the year about March and April, when the spot activity was decidedly feeble. This diversity of behaviour shows that the connection between the spots and hydrogen prominences is less intimate than it has sometimes been stated to be. Nevertheless, the prominences also afford very distinct evidence of a continued decline, as the following figures, given by the Rev. S. J. Perry in the *Observatory* for March, will show:—

	Mean height of chromosphere. ″	Mean height of prominences. ″	Mean extent of prominence arc. ° ′
1886	8·05	24·78	13 36
1887	8·13	23·86	9 29
1888	8·06	20·96	6 46

The highest individual prominences recorded by Prof. Tacchini were 2′ in height, and were seen on January 10 and February 7.

The magnetic variation has also shown a decline during the year in fairly faithful parallelism to the sun-spots; indeed, the accordance has, according to Dr. R. Wolf, been closer in 1888 than in 1887. The following are the numbers he gives in the *Comptes rendus*, vol. cviii. No. 2:—

1888.	Wolf's relative numbers (Zurich). r.	Δr.	Variation in magnetic declination (Milan). v. ′	Δv. ′
January	13·0	– 0·1	3·03	–0·68
February	7·0	– 8·7	3·02	–0·67
March	6·3	+ 3·6	7·11	+0·12
April	3·9	– 3·6	8·27	–1·06
May	7·8	– 9·4	8·48	–0·82
June	6·5	– 9·8	9·27	–0·28
July	1·9	–24·3	8·58	–1·67
August	1·9	–19·2	9·17	+0·10
September	7·8	+ 0·9	7·31	+1·23
October	2·0	– 3·5	6·32	+0·29
November	12·9	+ 8·4	2·18	–0·89
December	9·9	–10·6	1·76	–0·47
Mean	6·7	– 6·4	6·21	–0·40

The formula $v = 5'{\cdot}62 + 0{\cdot}045r$, which Dr. Wolf has established for Milan, would give $v = 5'{\cdot}92$ if $r = 6{\cdot}7$, whilst the observed value of v was $6'{\cdot}21$, a difference of $0'{\cdot}29$. The difference between the observed and computed values was $0'{\cdot}40$ for 1887.

COMET 1889 *a*.—This object, discovered by Mr. Brooks on January 14, appears to be lost. Prof. Holden, writing on January 30 to the editor of the *Astronomische Nachrichten*, states that both Mr. Barnard and Prof. Swift had carefully searched for it with the Lick instruments, but without success.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1889 MARCH 10–16.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on March 10

Sun rises, 6h. 26m.; souths, 12h. 10m. 21·6s.; sets, 17h. 54m.: right asc. on meridian, 23h. 23·8m.; decl. 3° 54′ S. Sidereal Time at Sunset, 5h. 8m.

Moon (at First Quarter on March 9, 18h.) rises, 10h. 41m.; souths, 18h. 53m.; sets, 3h. 9m.*: right asc. on meridian, 6h. 7·2m.; decl. 21° 54′ N.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. and declination on meridian. h. m.	° ′
Mercury	5 39	10 28	15 17	21 40·7	14 15 S.
Venus	7 18	14 52	22 26	2 5·6	16 54 N.
Mars	7 12	13 46	20 20	0 59·9	6 4 N.
Jupiter	3 14	7 10	11 6	18 22·5	23 2 S.
Saturn	14 16	21 54	5 32*	9 9·2	17 38 N.
Uranus	20 43*	2 8	7 33	13 19·3	7 40 S.
Neptune	8 55	16 38	0 21*	3 51·8	18 30 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Mar.	h.	
13	11	Mercury at greatest elongation from the Sun, 28° west.
14	6	Saturn in conjunction with and 1° 0′ south of the Moon.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
W Tauri	4 21·7	15 51 N.	Mar. 12,		*M*
R Canis Majoris	7 14·5	16 11 S.	,, 11,	19 57	*m*
		and at intervals of		27 16	
S Geminorum	7 36·4	23 43 N.	Mar. 14,		*M*
S Cancri	8 37·6	19 26 N.	,, 11,	18 38	*m*
T Cancri	8 50·3	20 16 N.	,, 14,		*M*
R Ursæ Majoris	10 36·8	69 22 N.	,, 15,		*m*
R Crateris	10 55·1	17 44 S.	,, 16,		*m*
U Coronæ	15 13·7	32 3 N.	,, 11,	0 32	*m*
S Serpentis	15 16·5	14 43 N.	,, 11,		*M*
T Vulpeculæ	20 46·8	27 50 N.	,, 10,	21 0	*m*
			,, 11,	23 0	*M*
Y Cygni	20 47·6	34 14 N.	,, 10,	5 40	*m*
			,, 13,	5 40	*m*
δ Cephei	22 25·0	57 51 N.	,, 10,	20 0	*m*

M signifies maximum; *m* minimum.

Meteor-Showers.

	R.A.	Decl.	
Between Lynx and Auriga	98 ...	46 N.	
Near ν Virginis	175 ...	10 N. ...	Slow; bright.
,, κ Cephei	300 ...	80 N. ...	Slow; bright.

GEOGRAPHICAL NOTES.

M. ROLLAND, a French naturalist, charged with an official mission to Madagascar, has sent in his Report to the Minister of Public Instruction. M. Rolland sums up his geographical observations by remarking that, notwithstanding its apparently simple contour, the topography of Madagascar is exceedingly complex. Behind the line of lagoons which border the coast, and which, except that the water is salt, remind one of the *étangs* of Languedoc, the hills begin to rise, and increase in height towards the interior. Behind these, again, the mountains rise by stages to a height of over 6500 feet. The surface is cut up by innumerable ravines, at the bottom of which are torrents, which rush on their way towards the Indian Ocean. This chain forms the backbone of the island, and consists mainly of Primary and crystalline rocks. When it is crossed, the Mozambique Channel is reached. The two slopes, east and west, are very unequal in extent. The former, which M. Rolland has explored to a considerable extent, occupies more than one-third of the total area of Madagascar. A broad valley, that of the Mangoro, runs north and south, parallel to the great central chain and the coast. Unfortunately, the Mangoro is not navigable, even for canoes. The two other most important rivers are the Manangoro and the Mangataka; and these three rivers, with innumerable streams, render this part of the island one of the best-watered regions on the globe. The climate varies considerably from one zone to another. On the east coast the temperature oscillates between 13° and 30° C.; on the west coast, it never descends below 17°; in Imerina province it ranges from 5° to 25°. M. Rolland refers in some detail to the well-known characteristics of the fauna of Madagascar, and to the abundance of mineral treasures, especially iron, copper, and lead; but, he states, the natives carefully conceal the localities of the beds.

LIEUT. VANS AGNEW has undertaken a journey to the Upper Salween and South-Eastern Tibet, with the object of attempting the solution of the problem of the course of the Lu River—whether to the Irawadi or the Salween—propounded by General J. T. Walker in his paper read to the Royal Geographical Society on April 25, 1887. The Council of the Society have sanctioned a contribution of £100 towards the expenses of the expedition. Lieut Vans Agnew leaves India for the Salween in the course of the present month.

AT the February meeting of the Berlin Geographical Society Dr. A. Schenck read a report on his recent journey in Nama Land and Herero Land, South-West Africa. He showed that the whole country between Walfisch Bay and the Orange River is—in consequence of the purely mechanical decomposition of the prevailing granitic rock, which is taking place under the great daily variations of temperature, causing in many places the disintegrated surfaces to be eaten away in the form of a crust—covered over with a sea of sand and granitic shingle, from which the highest elevations stand out like islands. The country is not suited for agricultural colonies. The coast and the interior stand in contrast with regard to the season of rainfall. While on the coast the rain falls mostly in winter, the rainfall in the interior occurs only in summer, and nearly always in the form of thunder-showers, which, as Dr. Schenck believes, are caused by the condensation of the moisture-laden air, which is brought to this part by the warm, humid, north-east winds from the more equatorial regions of Africa, through coming into contact with the cool south-west winds blowing from the coast to the interior. As to the configuration of Great Nama Land, Dr. Schenck gives the following notes. After the hilly coast-region between Angra Pequena and Aos is passed, a broad valley-like depression is reached, filled up with drift-sand. East of the depression the country ascends and forms a stony, desolate plain, out of which rise isolated peaks or longer mountain-chains running in a north and south direction. The whole of this district, as far as Aos, forms a connected mountain system composed of ancient rocks, granite, and gneiss, which has been buried by the sand from which the higher parts stand out. Beyond Aos the traveller enters upon the steppe region, which is divided into detached plateau districts. Beyond Aos and the river-bed of the Goăgib, on which the station of Bethanien is situated, the Huib plateau stretches away to the north, as far as the region of Khuias, and to the south to a point a few miles north of the Orange. A long series of table-mountains, resembling in form truncated cones, mark the western escarpment of this plateau; the former are composed of granite and gneiss, and are covered with limestone and sandstone, horizontally laid down. East of Bethanien, and corresponding with the line of a long geological fault, is the escarpment of another plateau; it is about 5000 feet in height. It descends to the Great Fish River on the east; on the other side of the river, the plateau character of the country is continued to the Karas Plateau, which extends into the brush steppe of the Kalahari. Further details concerning this interesting region will be found in the March number of the Proceedings of the Royal Geographical Society.

THE FORCES OF ELECTRIC OSCILLATIONS TREATED ACCORDING TO MAXWELL'S THEORY. BY DR. H. HERTZ.[1]

II.

Note by the Translator.

IT is to be noted that Hertz follows the French system of wave-lengths and periods. Had I noticed this before the diagrams went to the engraver, I would have altered it, and interpreted his T as $\frac{1}{2}$T, &c., throughout. As it is, I have left them everywhere as in the original. My elaborate attempt to evade a literal translation of *Doppelpunkt* was quite unnecessary. Prof. Karl Pearson has sent me a reference to Maxwell's definition of "double-point" in vol. i. Art. 129, first edition of "Electricity and Magnetism."—O. J. L.

In order now to ascertain the distribution of force for the remaining parts of space we may use graphic representation, constructing for definite times the lines of electric force, viz. the curves Q = const., for equi-distant values of Q.

Since Q itself is the product of two factors, of which one depends only on r, the other only on θ, the construction of these curves presents no great difficulty.

We decompose every value of Q for which we want the curve into two factors in different ways; we determine the angle θ for which $\sin^2 \theta$ is equal to the one factor, and by means of an auxiliary curve that value of ρ for which the function of ρ contained in Q is equal to the other factor; we thus get as many points as we please of the curve. When one attempts to carry out the construction one perceives many small processes which it would be prolix to detail here. We will content ourselves with examining the results of such construction, as exhibited in Figs. 1, 2, 3, 4.

These figures represent the distribution of force at the times $t = 0$, $\frac{1}{4}$T, $\frac{1}{2}$T, $\frac{3}{4}$T; and also, by suitable inversion of the arrows, for all future times which are similar multiples of $\frac{1}{4}$T. At the origin is shown, in the correct aspect and about of the right proportional size, the arrangement by which in our earlier experiments the oscillations were excited.

The lines of force are not indicated right up to the picture because our formulæ regard the oscillators as infinitely short, so in the neighbourhood of a finite oscillator they are insufficient.

Let us begin a study of the figures with Fig. 1. Here, when $t = 0$ the radiation is in the condition of its strongest development, but the poles of the straight oscillator are not electrically charged—no lines of force start thence. Such lines of force begin, however, now from the time $t = 0$ to start out from the poles; they are inclosed in a sphere which expresses the value Q = 0. In Fig. 1 this sphere is indeed still vanishingly small, but it enlarges itself quickly, and by the $t = \frac{1}{4}$T it fills already the space R_1 (Fig. 2). The distribution of lines of force inside the sphere is approximately of the same kind as correspond to a static electric charge on the pole. The speed with which the spherical surface Q = 0 spreads out from the origin is at first much greater than $\frac{1}{A}$ [or "v"]; in fact, the latter velocity would only correspond to

[1] Translated and communicated by Dr. Oliver Lodge. Continued from p. 404.

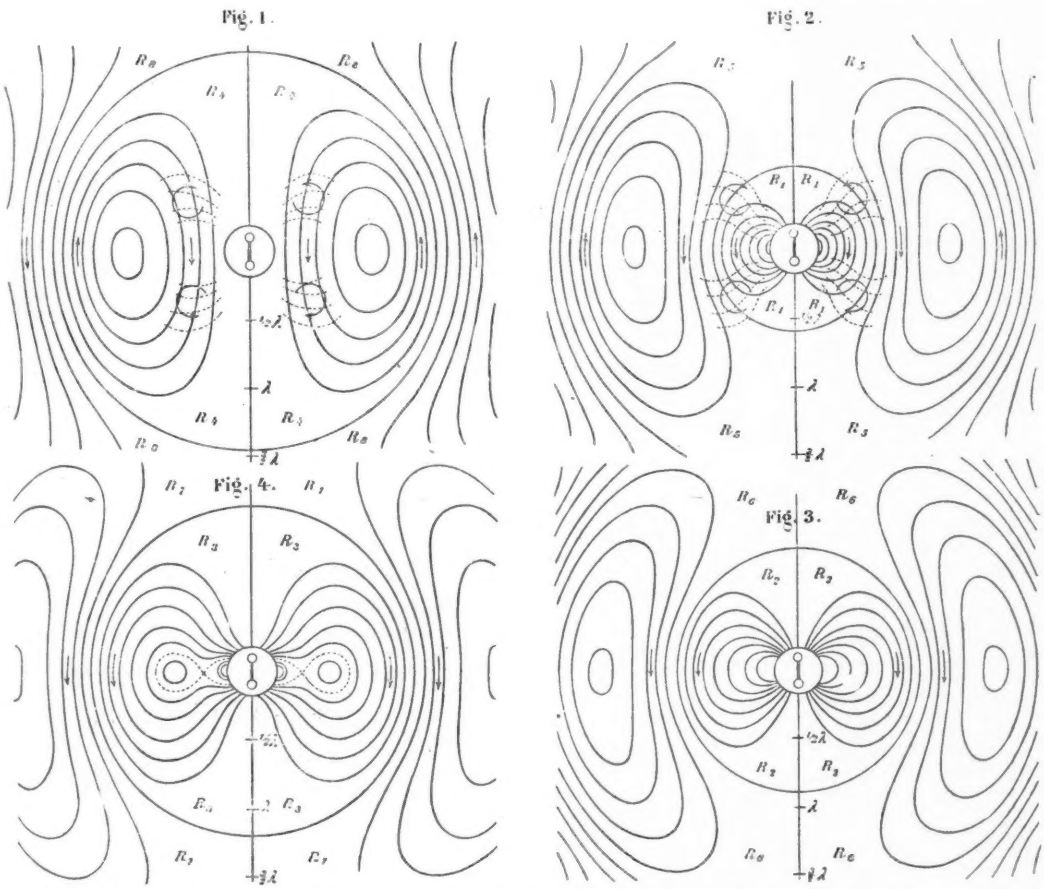
the distance given in the figure as $\frac{1}{4}\lambda$ for the time $\frac{1}{4}$T. At infinitesimal distance from the origin the velocity of outspreading is indeed infinite.

This phenomenon it is which we represented in the old mode of expression by saying that along with the inductive action travelling with the velocity of light there was superposed an electrostatic force travelling with infinite speed.

We properly express this phenomenon in terms of our present theory when we remark that fundamentally the self-forming waves do not arise solely from processes occurring at the origin, but are influenced by the condition of the whole surrounding medium, which latter, according to Maxwell's theory, is the true seat of the energy. However this may be, the surface $Q = 0$ expands with a velocity which gradually reduces to $\frac{1}{A}$, and by the time $t = \frac{1}{2}$T it fills the space R_2 (Fig. 3). By this time the electrostatic charging of the pole is at its greatest development; the number of lines of force which start thence attains its maximum value.

With further increase of time no fresh lines of force protrude from the poles; rather, those already produced begin to withdraw back into the conductor, there to vanish as lines of electric force, their energy, however, being converted into magnetic energy.

Hence occurs a singular behaviour which in Fig. 4 ($t = \frac{3}{4}$T) is plainly to be recognized, at least in its beginning. The lines which have furthest removed themselves from the origin get



These figures correspond to successive stages in the history of a semi-oscillation. Ignoring the arrows, Fig. 1 represents the state of things at the end of every half-period; Fig. 3 at the end of every quarter-period; Figs. 2 and 4 represent one-eighth and three-eighths of a complete oscillation respectively. I do not feel clear about the correctness of the straight arrows in Fig. 1.

drawn together by the stress with a lateral inflexion; this inflexion approaches nearer and nearer to the axis of z; and then a self-closed portion detaches itself from each of the outer lines of force, which automatically spread out into space, while the residue sink back into the conductor.

The number of receding lines is just as great as the number of originally expanding lines; their energy, however, is necessarily diminished by the energy of the detached portion. This loss of energy corresponds to the radiation into space. In consequence of it the oscillation must soon come to rest unless some impressed forces restore the energy lost to the source. Meanwhile we have regarded the oscillations as undamped, and thus implicitly understood the existence of such forces.

In Fig. 1, to which we can now return for the time $t =$ T, since we can imagine the arrows inverted, the detached portions of the lines of force fill the space R_4, while the lines starting from the poles have completely vanished. But new lines of force break out from the pole, and compress the lines whose early history we have followed into the space R_5 (Fig. 2).

It needs no further explanation now to follow these lines into the spaces R_6, R_7, and R_8. More and more they transform themselves into a pure transverse wave motion, and lose themselves as such in the distance. One would get the best picture of the play of force if one made a series of drawings for still smaller time-intervals, and examined them with a stroboscopic disk.

A closer consideration of the figures shows that the direction of the force changes from instant to instant for such points as lie either in the axis of z or in the plane xy. If we represent the force at a point, therefore, in the customary way by a line, the end point of this line oscillates, not indeed in a straight line, but in an ellipse. In order to see whether there are points for which this ellipse approximates to a circle, in which, therefore, the forces go through all the directions of a windrose without important change of magnitude, let us superpose two of the representations expressing times which differ by $\frac{1}{4}$T ; for instance, Figs. 1 and 3, or 2 and 4.

For the points we seek, the lines of the one set must plainly cut those of the other system orthogonally, and the distances of the lines of the one figure must be equal to those of the other. The small quadrangles formed by the superposition of the two systems must therefore be squares for the sought points.

There may be now remarked, in actual fact, a region of the kind sought : it is represented in Figs. 1 and 2 by circular arrows, whose directions give at once the direction of the rotation of the force. The dotted lines are inserted for convenience ; they belong to the line system of Figs. 3 and 4.

One finds, moreover, that the force exhibits the behaviour here described, not only at the specified points, but also in the whole strip-formed region which, spreading out from those points, forms the neighbourhood of the z axis. Nevertheless, the magnitude of the force decreases so quickly in these directions, that only in the points above-mentioned can its singular behaviour be important.

The system of forces now described and required by theory can be quite well recognized in an incomplete observation, not hitherto indicated by theory, which I formerly described (*Wied. Ann.* xxxiv. p. 155, 1888). One cannot, indeed, explain everything about those experiments, but one can get the main points correctly.

By both experiment and theory the distribution of force in the neighbourhood of the oscillator is chiefly an electrostatic distribution. By both experiment and theory the force spreads out chiefly in the equatorial plane and decreases in that plane at first quickly, afterwards slowly, without being zero at a mean distance. By both theory and experiment the force, in the equatorial plane, in the axis, and at great distances, is of constant direction and varying magnitude, while at intermediate points it changes its magnitude but little and its direction much. The correspondence between theory and those experiments only breaks down in this, that at great distances, according to theory, the force remains always normal to the straight line through the source, while by experiment it appears to be parallel to the oscillator. For the neighbourhood of the equatorial plane where the forces are strongest this follows from the equations too, but not for directions which lie between the equatorial plane and the axis. I believe that the error is on the side of experiment. In these experiments the direction of the oscillator was parallel to both the main walls of the laboratory, and the component of the force which was parallel to the oscillator might be thereby strengthened in proportion to the normal components.

I have therefore repeated the experiment with a different arrangement of the primary oscillator, and found that with certain arrangements the result corresponds with theory. I did not attain an exact result, but found that at great distances, and in regions of small intensity of force, disturbances due to the boundary of the space available were already too considerable to permit a safe verdict.

While the oscillator is at work, the energy vibrates in and out of the spherical surfaces surrounding the origin. More energy goes out, however, through any spherical surface during an oscillation than comes back ; and indeed the same excess quantity goes through all spherical surfaces. This extra quantity represents the loss of energy during the period of swing due to radiation. We can easily calculate its value for a spherical surface whose radius, ρ, is so great that it is permissible to employ a simplified formula. Thus the energy going out of the spherical zone between θ and $\theta + d\theta$ in the time dt will be—

$$2\pi\rho \sin\theta\, \rho d\theta\, dt.\frac{\mathrm{P}}{4\pi\mathrm{A}}\,(\mathrm{Z}\sin\theta - \mathrm{R}\cos\theta).$$

Putting into this the values of Z, P, and R, which are proper for great distances, and integrating from $\theta = 0$ to π, and from $t = 0$ to T, we get, as the energy going out through the whole sphere during every half complete swing,—

$$\tfrac{1}{3}\mathrm{E}^2 l^2 m^3 n\mathrm{T} = \frac{\pi^4\mathrm{E}^2 l^2}{3\lambda^3}.$$

Let us try to obtain an approximate estimate of the amount of this corresponding to our actual experiments. In those we charged two spheres of 15 centimetres radius in opposite senses up to a spark length of 1 centimetre about. We may estimate the difference of potential between these spheres as 120 C.G.S. electrostatic units, so each sphere was charged to half this potential, and its charge was therefore E = 900 C.G.S. units.

The total store of energy which the oscillator originally possessed amounted to 60 × 900 = 54,000 ergs, or 55 centimetre-grammes. The length of the oscillators, moreover, was 1 metre approximately, and the wave-length was about 480 centimetres.

So the loss of energy in half a swing comes out about 2400 ergs. It seems, therefore, that after eleven half-swings one-half of the energy must have gone in radiation. The quick damping which the experiments made manifest was therefore necessitated by radiation, and could not be prevented even if the resistance of conductor and spark were negligible.

A loss of energy of 2400 ergs in 1·5/100,000,000 of a second means a performance of work equal to 22 horse-power. The primary oscillator must be supplied with energy at at least this rate if the oscillation is to be permanently maintained at constant intensity in spite of the radiation. During the first few oscillations the intensity of the radiation at about 12 metres distant from the vibrator corresponds with the intensity of solar radiation at the surface of the earth.

(*To be continued.*)

GENERAL EQUATIONS OF FLUID MOTION.

THE general equations of the motion of a fluid can all be comprehended in a single form, which seems to be deserving of special notice.

Taking the ordinary notation, u, v, w, for the velocity-components at any point, P, of the fluid at any instant, and denoting the components of vortical spin at the point by ω_1, ω_2, ω_3, the usual Cartesian equations can be at once put into the form—

$$\frac{du}{dt} + \frac{d}{dx}\left(\tfrac{1}{2}q^2 + \int\frac{dp}{\rho}\right) + 2(w\omega_2 - v\omega_3) = \mathrm{X},$$

and two analogues, q being the resultant velocity. If through the point P we draw any curve whatever, the direction-cosines of whose tangent are l, m, n, and multiply the above and its two analogues, respectively, by l, m, n, we obtain by addition the equation—

$$\frac{d\dot{s}}{dt} + \frac{d\mathrm{U}}{ds} + 12\Delta = \mathrm{S} \quad . \;.\; .\; .\; .\; .\; .\; (\alpha)$$

in which $\dot{s}$ stands for the component of velocity along the tangent to the curve, $\mathrm{U} = \frac{1}{2}q^2 + \int\frac{dp}{\rho}$, S = component of external force-intensity along the tangent, and Δ is the volume of the tetrahedron formed by the vector drawn at P to represent q, the resultant velocity, the vector drawn to represent Ω, the resultant vortical spin, and the vector representing a unit length along the tangent to the curve at P. (Strictly speaking, the notation $\dot{s}$ is not a good one, but it is the best that presents itself.)

This equation (α) is that which I propose, as typical of all fluid motion, and as including all the special Cartesian equations in current use.

Some simple results follow at once for the case of steady motion. Thus, if we integrate (α) between any two points, A, B, of the curve,

$$\mathrm{U_B} - \mathrm{U_A} + 12\int\Delta ds = \int \mathrm{S}ds \quad . \;.\; .\; .\; .\; (1)$$

where $\mathrm{U_B}$ and $\mathrm{U_A}$ are the values of U at B and A.

Now, in particular, if the curve drawn at P is a stream-line, $\Delta = 0$ at every point of it ; also, if the curve is a vortex-line, $\Delta = 0$ at every point, and we have the simple result,

$$\mathrm{U_B} - \mathrm{U_A} = \int \mathrm{S}ds \quad . \;.\; .\; .\; .\; .\; .\; .\; (2)$$

a result which has long been known for a stream-line, but, apparently, not so long known for a vortex-line. It holds also for an infinite number of curves that can be drawn through P, all lying on a certain surface, as is pointed out by Lamb ("Motion of Fluids," p. 173), the surface in question being formed of a network of stream- and vortex-lines. That such surfaces exist in the fluid when the external forces have a potential, is proved most satisfactorily by taking the integral of (a) along a circuit through P, of which a part consists of stream-line and a part of vortex-line; but into the details of this we need not enter.

I observe, also, that this equation (2) holds for the portion of any curve whatever connecting any two points, A, B, on a network surface, although this curve does not lie on the surface.

Another point to which I would call attention is an analytical expression of the state of non-vortical motion. The physical expression has, of course, reference to the non-rotation of the three principal axes of the little ellipsoid into which, at each instant, a small sphere is deforming. The analytical expression of the fact takes usually the form that there is a velocity potential, *i.e.* $\frac{du}{dy} = \frac{dv}{dx}$, with two Cartesian analogues. Here, again, I would suggest a single equation, having no reference to special axes. This equation is simply

$$\frac{d\dot{s}}{d\sigma} = \frac{d\dot{\sigma}}{ds} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; (\beta)$$

where s and σ denote arcs of *any two curves whatever* drawn at the point P, and $\dot{s}$ and $\dot{\sigma}$ the component velocities of the fluid along them.

It is obvious that these contain the whole three of the usual Cartesian expressions. The proof is very easy.

Cooper's Hill. GEORGE M. MINCHIN.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The following Examiners in Natural Science have been appointed for the Honour Examinations:—Mr. J. V. Jones and Mr. A. L. Selby (Physics); Prof. McLeod and Mr. V. H. Veley (Chemistry); Prof. Milnes Marshall and Mr. W. Hatchett Jackson (Morphology); Prof. Sanderson and Prof. Schäfer (Physiology); Prof. Boyd Dawkins and Prof. Green (Geology).

The conditions of tenure of the Burdett-Coutts Geological Scholarship are to be altered, so as to make it necessary for the holders to devote themselves to Geology, and to work with the Professor.

Scholarships in Natural Science are announced for competition at Merton and at New College. The examination begins on July 2.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 21.—"The Influence of Bile on the Digestion of Starch. (1) Its Influence on Pancreatic Digestion in the Pig." By Sidney Martin, M.D., B.Sc., British Medical Association Scholar, and Dawson Williams, M.D. (From the Physiological Laboratory, University College, London.)

The experiments of the authors have shown that if pig's bile be added to a solution of starch with pancreatic extract the digestion goes on with greater rapidity than without the bile. The rapidity of digestion is increased with the addition of quantities up to 4 per cent. of dried bile (equivalent to at least 30 per cent. of fresh bile). The rapidity was tested by noticing when the iodine reaction of starch had disappeared. On further research, it was found that this property of the bile depended on the bile salts (hyoglycocholate of sodium). The increased rapidity of digestion was well seen if 0·6 to 2 per cent. of bile salts were added to the digestive mixtures.

It was also found that not only was the change of starch into dextrine hastened, but also the change into sugar; and that the amount of dextrine and sugar formed when bile-salts wer· present was one-fifth more than when they were absent. Fo the methods used in estimating the amount of dextrine and sugar, the original paper must be consulted.

"The Innervation of the Renal Blood-vessels." By J. Rose Bradford, M.B., D.Sc., George Henry Lewes Student. Communicated by E. A. Schäfer, F.R.S. (From the Physiological Laboratory of University College, London.)

The research was undertaken in order to map out the origin, cause, and nature of the renal nerves in the dog more accurately than had hitherto been attempted. The method employed consisted in exciting the roots of the spinal nerves, and observing simultaneously the effects produced on the general blood-pressure and on the volume of the kidney, the latter being investigated by means of Roy's oncometer. The anæsthetics used were chloroform and morphia. The general results were shortly as follows:—

No efferent vasomotor fibres were found in the posterior roots.

The efferent vasomotor fibres for the blood-vessels of the kidney leave the cord in the anterior roots of the nerves, extending from the second dorsal to the second lumbar. The renal nerves are, however, most abundant in the tenth, eleventh, twelfth, and thirteenth dorsal nerves.

In individual cases, however, there may be small variations in the number of fibres going on the one hand to the kidney, and on the other hand to the other abdominal viscera.

When quick rates of excitation are used, only contraction of the kidney and increase of general blood-pressure are observed, *i.e.* the vaso-constrictor fibres are excited.

With slow rates, however, expansion of the kidney with no increase of blood-pressure occurs, *i.e.* the vaso-dilator fibres are stimulated.

Hence the renal vessels not only receive constrictor fibres, but also dilator, and these are also most abundant in the eleventh, twelfth, and thirteen dorsal nerves.

Similarly when the peripheral end of the divided splanchnic nerve is excited with slow rates, a fall of blood-pressure is observed instead of the rise seen with quick rates.

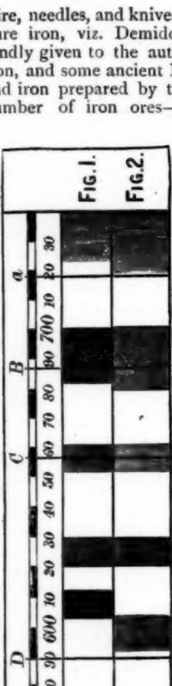
Hence the splanchnic contains not only vaso-constrictor fibres for the abdominal vessels, but also vaso-dilators.

The results of reflex excitation can be summed up shortly by saying that the excitation of an afferent nerve causing a rise of blood-pressure is accompanied by a renal contraction, unless the nerve is one of what may be called the renal area. In this case the rise of blood-pressure is accompanied, as a rule, by either a renal expansion or else by a mixed kidney effect.

The main conclusion of this communication is the demonstration of dilator fibres in the splanchnic and in the renal nerves, and also the fact that these vaso-dilator fibres reach the kidney by the same paths as the constrictor fibres.

Chemical Society, February 7.—Mr. W. Crookes, F.R.S., in the chair.—The following papers were read:—Researches on the constitution of azo- and diazo-derivatives; compounds of the naphthalene-β-series (continued), by Prof. R. Meldola, F.R.S., and Mr. G. T. Morgan.—The action of nitric acid on anthracene, by Mr. A. G. Perkin. Hitherto, only anthraquinone and nitro-anthraquinones have been obtained by treating anthracene with nitric acid; the author, however, finds that nitro- and dinitro-anthracene can readily be prepared by the action of nitric acid upon anthracene if care is taken at once to decompose any nitrous acid which may be formed.—The preparation of glyceric acid, by Dr. Lewkowitsch.—The relation of cobalt to iron as indicated by absorption-spectra, by Dr. W. J. Russell, F.R.S., and Mr. W. J. Orsman, Junr. It is well known that when examined spectroscopically, some coloured metallic compounds are found only to produce a general absorption, but from previous observations it seemed possible to the authors that in some cases at least this might be resolved into bands by employing more powerful chemical agents than are generally used in such cases; experience had indicated that the chloride is usually the most suitable salt, and that it should be dissolved in chlorhydric acid and the liquid saturated with hydrogen chloride, also that, if possible, ether should be taken as solvent. Applying these views to iron, it was found that ferric chloride gave a banded spectrum strikingly similar to that of cobalt chloride. Irons of all kinds were examined: pig-iron, commercial cast-iron, and various manufactured articles; steel in the form of

wire, needles, and knives; and a number of specimens of reputed pure iron, viz. Demidorff's sheet-iron, a sample of which was kindly given to the authors by Mr. Crookes, electro-deposited iron, and some ancient Indian iron from Prof. Roberts-Austen, and iron prepared by the late Dr. Matthiessen. Also a large number of iron ores—hæmatite Elba ore, Welsh bog ore, micaceous ore, ordinary spathic ore, a spathic ore found in cryolite, for which the authors have to thank Dr. Müller; Giderite, pyrites from the chalk, wolfram and rouge. Iron was also separated from the ignited residue of blood. All the specimens examined gave the same result. Fig. 1 represents the bands seen in a solution of cobalt chloride to a scale of wave-lengths; the three most refrangible bands are easily photographed, but are not visible to the eye under ordinary conditions. The iron spectrum (Fig. 2) in general appearance closely resembles the cobalt spectrum, but the band which in cobalt is at 605 is slightly shifted nearer the blue, as shown in the diagram; there appears also to be a shift in the 501 band, but in the opposite direction. It was found that ether always dissolves out of the ferric chloride a substance which gave a band of extraordinary intensity, exactly agreeing in position with the 530 band in the cobalt spectrum; further, that on increasing the strength of the ethereal solution, other bands became visible, agreeing with the bands observed in the strong chlorhydric solution of ferric chloride, and differing only in the case of the 690 and 655 bands, which in the ethereal solution were nearer the blue. Fig. 2 is the spectrum observed in a solution of iron in chlorhydric acid, peroxidized by any ordinary means. For a variety of reasons the authors believe that this spectrum (Fig. 2) does not arise from the presence of cobalt in the iron. In the first place, there is a constant difference between the two spectra, as shown in the position and appearance of the band at 597. A trace of cobalt dissolved along with the iron gives the same spectrum as pure cobalt dissolved in chlorhydric acid. Again, on gradually increasing the strength of a pure cobalt chloride solution, the bands in the red are the first to appear, and the band at 530 is not visible until the general absorption has crept up as far as 580, completely blocking up the red end of the spectrum; in an ethereal solution from iron, on the contrary, this 530 band is the first to appear, and the bands in the red only become visible in comparatively strong solutions. Ether extracts the band-giving substance from the ferric chloride with great ease; but it abstracts nothing from the cobalt chloride. Again, on dissolving iron in chlorhydric acid, no bands are visible, and so long as the iron is in the ferrous state even ether extracts no band-giving substance; but on converting the ferrous into ferric chloride by nitric acid, or potassium chlorate, &c., the band-yielding substance is at once apparent. A known weight of Mr. Crookes's Demidorff iron was converted into chloride and dissolved in a known volume of ether, and the intensity of the bands compared with those given by cobalt chloride dissolved in a similar bulk of chlorhydric acid; it was found that approximately it required a weight of cobalt equal to that of the iron to give bands of similar intensity. Prof. J. Norman Lockyer, F.R.S., said that some years since, in a paper communicated to the Royal Society, he had suggested that there were many different molecular groupings of the same element possible, and that spectrum analysis would disclose these: if the same molecular grouping were demonstrated in several substances, then undoubtedly there was a common constituent. If the bands described by the authors represent a substance common to iron and cobalt, it should be possible to obtain spectroscopic evidence of its presence at some temperature on volatilizing the metals; although he had not fully studied cobalt and nickel comparatively, he had, in fact, found that under certain special conditions some of the spectroscopic appearances were common to both, and in such a marked degree as to render it improbable that they were caused by impurities. Dr. Perkin referred to the non-appearance of bands in an alcoholic solution of purpurin and their appearance in an ethereal solution, as an illustration of the influence of the solvent. Prof. Armstrong remarked that the slight shift of the bands which had been referred to did not necessarily indicate that different substances were primarily the cause of the absorptions, as it is well known that such effects were observed on employing different solvents; the absorbing substance might in the one case be held in combination more firmly than in the other; this view was in harmony with the statement that ether did not extract the band-yielding subtance in all cases. Dr. Russell in reply said that not the spectrum as a whole, but only one of the bands was shifted. His view was that the solvents had broken up the substance into a finer state.—Note on methyl fluoride, by Dr. N. Collie. Methyl fluoride assumes the critical state at 44°·9 C. and at a pressure of 47,123 mm. This pressure is probably slightly too high, owing to a trace of air, and the temperature too low. The error in pressure probably does not exceed 1500 mm., and of temperature 0°·2 C.—The nitration of naphthalene-β-sulphonic acid, by Prof. H. E. Armstrong, F.R.S., and Mr. W. P. Wynne. According to Cleve three isomeric α-nitro-β-sulphonic acids are produced on nitrating naphthalene-β-sulphonic acid; the chlorides of which melt respectively at 169°, 140°, and 125°. The authors find, contrary to the view put forward provisionally by Cleve (*Ber. der Deut. Chem. Gesells.*, xxi. 3275), that the first compound is a heteronucleal derivative and corresponds in constitution with the dichloronaphthalene melting at 63°·5. All attempts to obtain the sulphochloride of intermediate melting-point have been unattended with success.—Action of bromine and chlorine on the salts of tetrethylphosphonium, by Prof. O. Masson and Mr. J. B. Kirkland.—Preparation of the salts of triethylsulphine, tetrethylphosphonium, and analogous bases, by the same.



Linnean Society, February 21.—Mr. Carruthers, F.R.S., President, in the chair.—Mr. George Murray exhibited a fossil Alga, *Nematophycus Logani*, Carr.—Mr. G. C. Druce exhibited some rare British plants from Scotland, amongst which were *Calamagrostis borealis*, *Ranunculus acris*, var. *pumilus*, and *Bromus mollis*, var. *decipiens*.—Prof. Marshall Ward exhibited a sclerotium of a Fungus produced from a Botrytis spore, and explained the method by which it had been obtained.—A paper was then read by Mr. F. Townsend, M.P., on *Euphrasia officinalis*, with a description of a new sub-species, and a discussion followed, in which the President, Mr. J. G. Baker, and others took part.—In the absence of the author, a paper by Mr. C. T. Druery, on sexual apospory in *Polystichum angulare*, was read by the Botanical Secretary, Mr. B. D. Jackson, upon which remarks were made by Mr. Murray and Dr. D. H. Scott.—Mr. Murray then gave the substance of a paper on a new genus of Green Algæ, proposed to be named *Boodlea*, and in so doing made some instructive observations on the affinities and distinguishing characters of allied genera. The paper was criticized by Messrs. A. W. Bennett, Reay Greene, and D. H. Scott.—In continuation of his researches upon the eyes of insects, Mr. B. T. Lowne gave an admirable exposition of the structure of the retina in the blow-fly, illustrated by preparations under the microscope, and some excellent photographs.

Geological Society, February 15.—Annual General Meeting.—Dr. W. T. Blanford, F.R.S., President, in the chair.—The Secretaries read the reports of the Council and of the Library and Museum Committee for the year 1888. The Council stated

that they had once more to congratulate the Fellows upon the prosperous state of the Society's affairs. The report of the Library and Museum Committee, after enumerating the additions made to the Society's Library and collections during 1888, referred briefly to the work done in the Museum, in the way of cleaning and putting it in order.—The President then presented the Wollaston Gold Medal to Prof. T. G. Bonney, F.R.S.; the Murchison Medal to Mr. William Topley, F.R.S., for transmission to Prof. James Geikie, F.R.S.; the Lyell Medal to Prof. W. Boyd Dawkins, F.R.S.; the Bigsby Medal to Mr. J. J. Harris Teall; the balance of the proceeds of the Wollaston Fund to Mr. A. Smith Woodward; the balance of the Murchison Geological Fund to Mr. Grenville A. J. Cole; and the balance of the proceeds of the Lyell Geological Fund to M. Louis Dollo. —The President read his Anniversary Address, in which, after giving obituary notices of Mr. W. Hellier Baily, Mr. H. Carvill Lewis, Vice-Admiral T. A. B. Spratt, Viscount Eversley, Mr. John Brown, Mr. W. Ogilby, and other deceased Fellows, together with notices of the Foreign Members and Correspondents of the Society who had died since the last anniversary meeting (Prof. Gerhard Vom Rath, Prof. T. Kjerulf, Prof. Giuseppe Meneghini, and Prof. Giuseppe Seguenza), he noticed the papers which had been published by the Society during the past year. The remainder of the address consisted chiefly of a discussion of the work of the International Congress from its commencement to the last meeting in London in 1888, and dwelt upon the influence which such meetings exercise upon the progress of geological science, quite apart from any formal resolutions which may be arrived at by the members.—The ballot for the Council and Officers was taken, and the following were duly elected for the ensuing year:—President: Dr. W. T. Blanford, F.R.S. Vice-Presidents: Dr. John Evans, F.R.S., Prof. T. McKenny Hughes, Prof. J. W. Judd, F.R.S., Prof. J. Prestwich, F.R.S. Secretaries: Mr. W. H. Hudleston, F.R.S., Mr. J. E. Marr. Foreign Secretary: Sir Warington W. Symth, F.R.S. Treasurer: Prof. T. Wiltshire. Council: Prof. J. F. Blake, Dr. W. T. Blanford, F.R.S., Prof. T. G. Bonney, F.R.S., Mr. James Carter, Dr. John Evans, F.R.S., Mr. L. Fletcher, Dr. A. Geikie, F.R.S., Prof. A. H. Green, F.R.S., Rev. Edwin Hill, Mr. W. H. Hudleston, F.R.S., Prof. T. McKenny Hughes, Prof. J. W. Judd, F.R.S., Major-General C. A. McMahon, Mr. J. E. Marr, Mr. E. T. Newton, Prof. J. Prestwich, F.R.S., Mr. F. W. Rudler, Prof. H. G. Seeley, F.R.S., Sir Warington W. Smyth, F.R.S., Mr. W. Topley, F.R.S., Rev. G. F. Whidborne, Prof. T. Wiltshire, Rev. H. H. Winwood.

Zoological Society, February 19.—Dr. St. George Mivart, Vice-President, in the chair.—Mr. Sclater exhibited specimens of the eggs and chicks of the Hoatzin (*Opisthocomus cristatus*) from a series collected by Mr. R. Quelch in British Guiana, and called attention to the extraordinary development of the wings in the chick, in reference to the statement that these organs are used like hands for climbing-purposes.—Mr. Sclater exhibited heads and skins of a new Antelope obtained by Mr. H. C. V. Hunter, in Eastern Africa, which he proposed to call *Damalis hunteri*, after its discoverer.—Sir E. G. Loder, Bart., exhibited and made some remarks on a skeleton of the Rocky Mountain Goat (*Haplocerus montanus*).—Dr. Günther exhibited a mounted specimen of Thomson's Gazelle (*Gazella thomsoni*), and pointed out its complete distinctness from Grant's Gazelle (*Gazella granti*). The specimen in question had been obtained in Masai-land by Mr. H. C. V. Hunter.—Mr. R. Lydekker read a paper on the skull of *Lytoloma*, an extinct genus of Chelonians allied to *Chelone*.—Mr. R. Lydekker pointed out the characters of an apparently new species of *Hyracodontotherium*, based on specimens from the phosphorites of Bach, near Lalbengue, in France. —Dr. A. Günther, F.R.S., described some new fishes from the Kilima-njaro district in Eastern Africa, based on specimens obtained by Mr. F. J. Jackson during his recent expedition into that country. He also exhibited a dried specimen of a fish obtained by Mr. H. C. V. Hunter from one of the crater-lakes in the same district, which he referred to a new genus and species of Chromidæ, proposed to be called *Oreochromis hunteri*. —Dr. Günther also exhibited a pair of horns of an Antelope obtained many years ago in the interior of Southern Central Africa, which were remarkable for their length and gentle backward curvature, with only a very slight twist near the tips. He referred these horns to a new species, proposed to be called *Antilope triangularis*.—Dr. Günther read some notes on a Bornean Porcupine, which he had formerly described as being without a tail, and named *Trichys lipura*. It now appeared that some specimens of this animal possessed a long and slender tail, but that other characters would necessitate the retention of the genus as distinct from *Atherura*.—Mr. F. E. Beddard read a paper directing attention to certain points in the anatomy of the Accipitres with reference to the affinities of *Polyboroides*. This form was shown to belong to the Falconidæ, and to have no real affinities with *Serpentarius*.—Sir Walter Buller read a paper on a species of Crested Penguin from the Auckland Islands, based on a specimen lately living in the Society's Gardens, which he proposed to call *Eudyptes sclateri*.

Anthropological Institute, February 26.—Dr. J. Beddoe, F.R.S., President, in the chair.—Mr. Francis Galton exhibited a new instrument for testing the delicacy of perception of differences of tint; also an instrument for telling reaction time. Both instruments will be exhibited in the Paris Exhibition.—Major C. R. Conder, R.E., read a paper on "The Early Races of Western Asia."

EDINBURGH.

Royal Society, February 4.—The Rev. Prof. Flint, Vice-President, in the chair.—Prof. T. R. Frazer read a paper on the natural history, chemistry, and pharmacology, of *Strophanthus hispidus*.—Mr. John Aitken exhibited and described his improved apparatus for counting the dust particles in the atmosphere.—Prof. Rutherford read a paper by Dr. G. N. Stewart, on the electrotonic variation in nerve with strong polarizing currents.

February 18.—Dr. Thomas Muir, Vice-President, in the chair.—Prof. Crum Brown communicated a paper by Mr. Alex. Johnstone, on the prolonged action of sea-water on pure natural magnesium silicates.—A paper by Dr. A. B. Griffiths on the so-called liver of *Carcinus mænas* was also read.—Dr. Muir communicated a paper by Mr. Alex. M'Aulay, Melbourne, on the differentiation of any scalar power of a quaternion, and a note by Prof. Tait on Mr. M'Aulay's paper.—Prof. Crum Brown read an account by Mr. Albert Campbell of the change in the thermo-electric properties of Wood's fusible metal at its melting-point.—Prof. Brown also read a paper by Mr. Frank Beddard on the anatomy and physiology of *Phreoryctes*.

PARIS.

Academy of Sciences, February 25.—M. Des Cloizeaux, President, in the chair.—Note on the question, whether their original infectious properties can be recovered by pathogenic microbes, which have apparently preserved nothing beyond the power of vegetating outside the living animal organism, by M. A. Chauveau. In continuation of his recent communication (*Comptes rendus*, cviii. p. 319), the author here describes some experiments which show that, in *Bacillus anthracis* apparently deprived of all infectious virulence, this virulence may be as easily restored as the simply diminished virulence is renovated in M. Pasteur's attenuated microbes. It results generally from these studies that in losing or recovering their virulence pathogenic microbes undergo no specific transformation. These physiological metamorphoses are merely an extension of the law well known to botanists that the conditions of culture may modify not only the form, but also and specially the functions of plants.—On some points in the theory of the sextant, by M. Gruey. The points here discussed are (1) the possibility of constructing the sextant with a single glass, which is decided in the affirmative, a means being indicated by which the practical inconvenience of such an instrument may be obviated; (2) the use of the transparent part of the small glass. This is suppressed by some, preserved by others, and M. Gruey considers that it is in fact useless.—On a question in the doctrine of probabilities, by M. E. Mayer. A solution is here proposed of M. Bertrand's 57th problem, dealing with the case of two players with equal chances and equal capital, and the probability of one ruining the other in a given number of throws.—Remarks on the conductivity and mode of electrolysis of concentrated sulphuric acid solutions, by M. E. Bouty. The main object of these experiments is to measure the molecular conductivity of sulphuric acid at or about the temperature of 0° C. An attempt is also made to determine the coefficients of temperature α and β in the formula—

$$C_t = C_0(1 + \alpha t + \beta t^2).$$

—On the electro-chemical measurement of the intensity of currents, by M. A. Potier. Arguments are advanced to show that the electrolytic measurement of intensity cannot be regarded

as rigorously accurate except on the condition of the electrodes presenting no trace of polarization. This condition is generally supposed to be strictly complied with when the electrodes are formed of molten metals; but the present researches prove that such is not always the case.—On the reciprocal influence of two rectangular magnetizings in iron, by M. Paul Janet. A piece of iron being magnetized in a given direction by a given magnetic force, the author inquires whether this magnetic state becomes modified by the establishing or interrupting a fresh magnetic current perpendicular to the first.—On drops of mercury as electrodes, by M. Ostwald.—A correction as regards the action of sulphurous acid on the alkaline thiosulphates, by M. A. Villiers. In a previous note (*Comptes rendus*, cvi. pp. 851 and 1354) the author described the sodium salt of a new oxy-acid of sulphur as obtained by the action of sulphurous acid on the sodium thiosulphate, and as having the formula $S_4O_8Na_2$. But he has since discovered that this salt contains two atoms of hydrogen, so that its formula is $S_4O_8Na_2H_4 = S_4O_6Na_2.2H_2O$; that is to say, it is hydrated tetrathionate of soda.—On the valency of aluminium, by M. Alphonse Combes. The vapour-density of $Al(C_5H_7O_2)_3$ at 360° in an atmosphere of nitrogen was found to be 11·25, agreeing with the above formula. Its valency at this comparatively low temperature therefore shows its analogy with indium and other triad elements.—Combination of mannite with the aldehydes of the fatty series: ethylic acetal, by M. J. Meunier. Two processes are described, by means of which the ethylic acetal of mannite may easily be prepared. The combination of mannite with an aldehyde of the aromatic series (benzoic aldehyde) has already been studied. It now appears that an acid solution of mannite, mixed with equal molecular weights of acetic and benzoic aldehydes, yields ethyl acetal, and not an acetal resulting from the simultaneous combination of the two aldehydes.—M. A. Haller describes the preparation of some new neutral and acid ethers of the camphols, and also gives an easy process for the separation of camphor and camphol.—M. Aimé Girard reports the results of some protracted experiments on the cultivation of the potato in France, with a view to the selection of the best tubers, and a more abundant yield of starch-producing roots.—M. G. Hayem studies the causes of the fatal effects resulting from the transfusion of blood between animals of different species, and more especially from the injection of dogs' blood in the rabbit.—The porphyritic rocks of Cavenac, near Saint-Pons, are described by MM. P. de Rouville and Auguste Delage; and those of the Forez district by M. U. Le Verrier.—M. Ed. Piette gives an account of some human and animal remains representing a transitional epoch between Quaternary and modern times, recently discovered by him in a cave on the left bank of the Arize.

Astronomical Society, February 6.—M. Flammarion in the chair.—M. Guiot, of Soissons, sent observations of Uranus made with the naked eye, and of Neptune with an opera-glass.—M. Schmoll showed diagrams of solar activity during 1888. He had noted 190 days without spots. M. Bruguière placed the minimum at 1888·8. MM. Lihou and Jacquot sent some remarks on the same subject.—M. Flammarion read a paper on γ Arietis, calling attention to the remarkable relative fixity of the two components. His measures at Juvisy gave 8″·51 and 359°·1.—M. Ch. Moussette made some remarks on the lunar eclipse of January 17.—General Parmentier read a note on the planetoids discovered in 1888, and showed that they confirmed the classification of those bodies which he published a few years ago.—M. Gunziger exhibited some Thompson's disks, and showed their utility for drawing and accurately placing sun-spots.

STOCKHOLM.

Royal Academy of Sciences, February 13.—Sir Joseph Lister was elected a Foreign Member of the Academy.—Prof. Wittrock gave an account of the present state of the Bergian Garden belonging to the Academy.—An examination of some Algæ referred to the genus Adenocystis, Hooker fil. et Harvey, by Prof. F. R. Kjellman.—Contributions to the flora of Medelpad, by Dr. L. M. Neuman.—Report on investigations relating to the flora and fauna of the peat-bogs of Scania, by Herr G. Andersson.—Report on investigations relating to the Ascomycetes, especially the coprophilous, of Öland, by Herr C. Starbäck.—A special case of the problem of three bodies, by Prof. Gyldén.—On Odonatæ collected during the Swedish Expedition to Yenisei in 1876, by Dr. F. Trybom.—*Ichneumones pneustici*, by the late Lector A. E. Holmgren.—An experiment with an electric spark and a small flame, by Dr. C. A. Mebius.—Prof. Nilsson gave an account of the researches of Dr. Krüss on cobalt and nickel.—On the singular points of the common algebraic differential equations, by Dr. J. Möller.—On maximi and minimi convergents of a certain class of distinct integrals, by Herr C. B. Cavallin.—On naphtoë acids, &c., by Dr. Ekstrand.—On the b^1-b^2-brom-naphthalin-sulphon acid, by Herr Forsling.—On the reaction of the fuming sulphuric acid on a^1-b^1-chlor-naphthylamin and on a^1-b^2-chloracetnaphthalid, both combined with hydrochloric acid, by Herr P. Hellström.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Mémoires de la Société de Physique et d'Histoire Naturelle de Genève, tome xxx. Première Partie (Genève).—History of the Linen Hall Library, Belfast: J. Anderson (Belfast).—Glimpses of Feverland: A. P. Crouch (Low).—Ueber den Einfluss der Festsitzenden Lebensweise auf die Thiere: Arnold Lang (Jena, Fischer).—Lehrbuch der Vergleichenden Anatomie, Erste Abthg.: Arnold Lang (Jena, Fischer).—Darwinism and Politics: D. G. Ritchie (Sonnenschein).—New South Wales, 1887, Report of the Minister of Public Instruction (Sydney, Potter).—Annual Report of the Department of Mines, N.S.W., for the Year 1887 (Sydney, Potter).—New South Wales Australian Museum, Report of Trustees for 1887 (Sydney, Potter).—New South Wales Report on Technical Education: E. Combes (Sydney, Potter).—Molekularphysik, Zweiter Band: Dr. O. Lehmann (Leipzig, Engelmann).—Histologische Beiträge, Heft 2: E. Strasburger (Jena, Fischer).—Ueber die Hypothese einer Vererbung von Verletzungen: Dr. A. Weismann (Jena, Fischer).—Intracellulare Pangenesis: H. de Vries (Jena, Fischer).—The Best Forage Plants fully described and figured: Drs. Stebler and Schröter; translated by A. N. McAlpine (Nutt).—Index of Publications on Methods of Communication in the Field, and on Torpedo Warfare: R. von Fischer-Treuenfeld (Alabaster).—Electricity in the Service of Man, Part 1, edited by R. Wormell (Cassell).—The Asclepiad, No. 21, vol. 6: Dr. B. W. Richardson (Longmans).—Note on the Lapps of Finmark: Prince Roland Bonaparte (Paris).—La Nouvelle-Guinée, 3rd Notice—Le Fleuve Augusta; 4th Notice—Le Golfe Huon: Prince Roland Bonaparte (Paris).—Himmel und Erde, Heft 6 (Berlin, Paetel).—Beiblätter zu den Annalen der Physik und Chemie, 1889, No. 2 (Leipzig, Barth).—Verhandlungen des Naturhistorischen Vereines, Fünfte Folge, 5 Jahrgang, Zweite Hälfte (Bonn, Max Cohen).—Geological Magazine, March (Trübner).

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